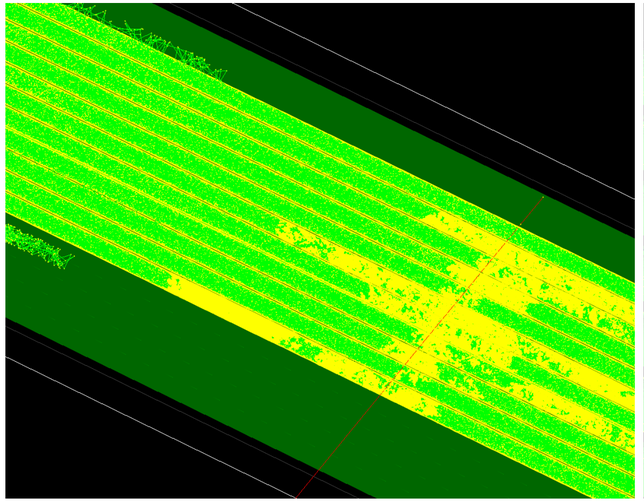
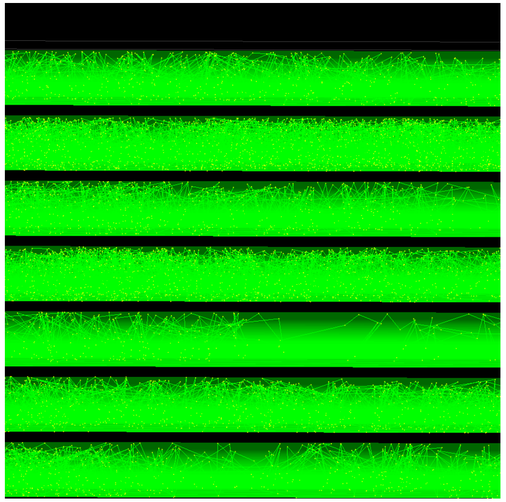
SpaCal — Light guide optimisation

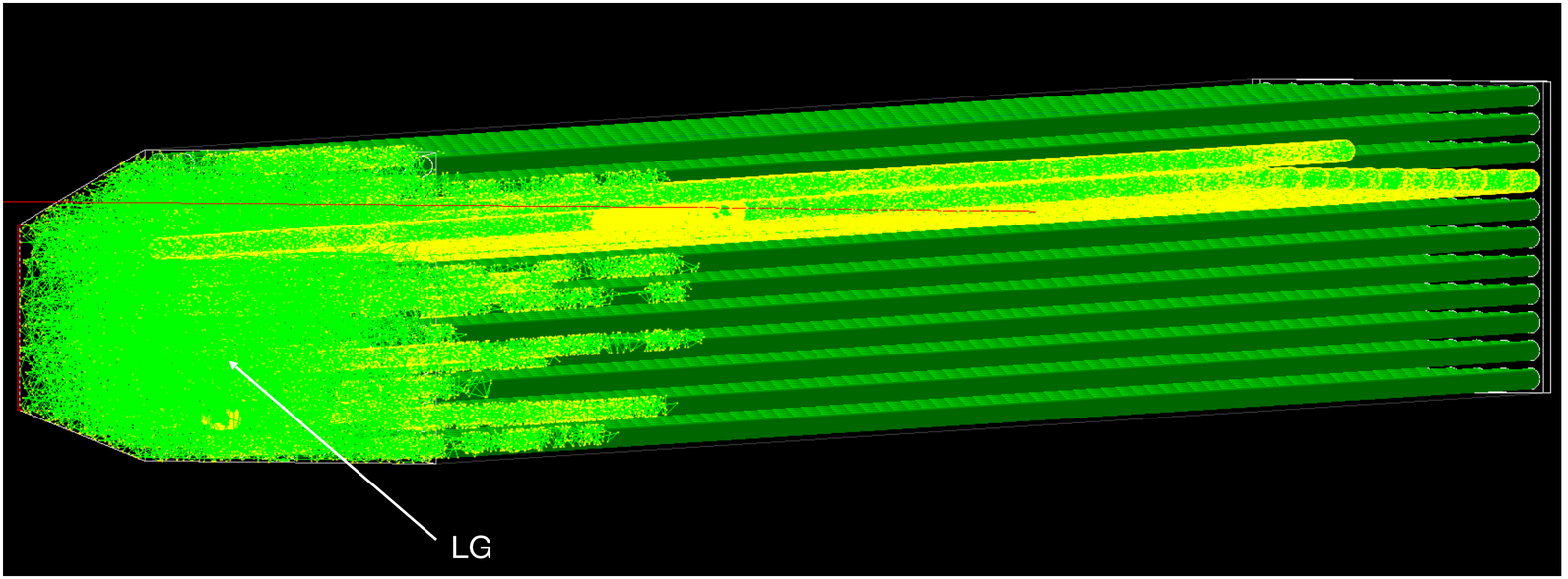
Model of SpaCal

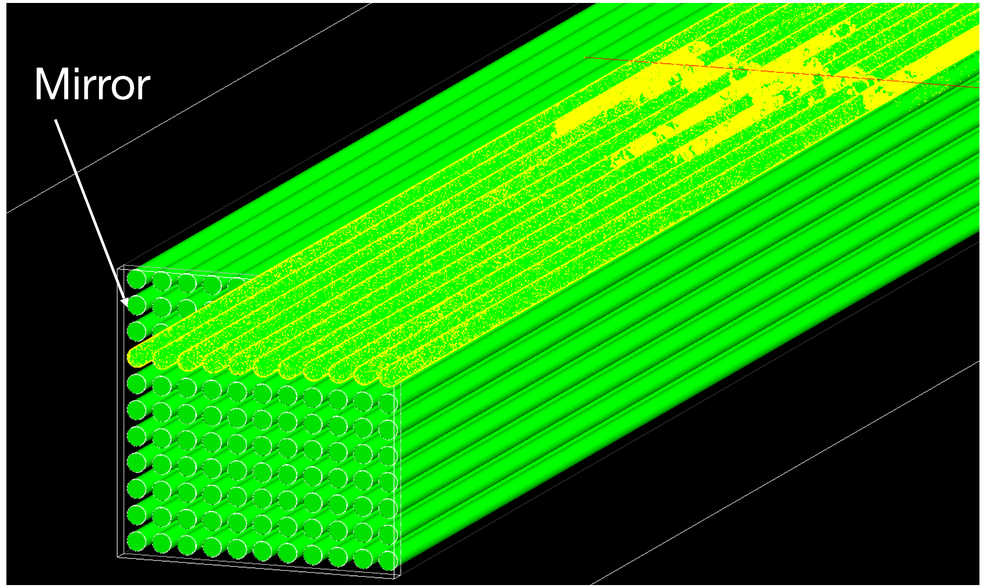
All materials properties was set same as in MyMaterial.cc in HybridMC

- Absorber — Pb — xy sizes — 30.25x30.25 mm; z — 30 cm;
- 11x11 fibres — Polystyrene core (without impurities) & PMMA cladding (without impurities) — in xy; radius—1 mm core + 0.03 mm cladding;
- SiPM-PMT — z — 0.4 mm;
- Mirror — reflective index 1.0 — 80% +- 10%



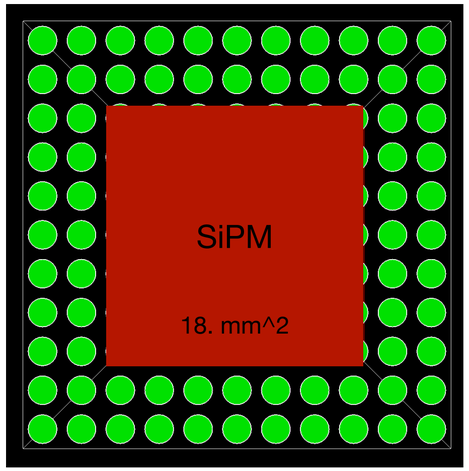


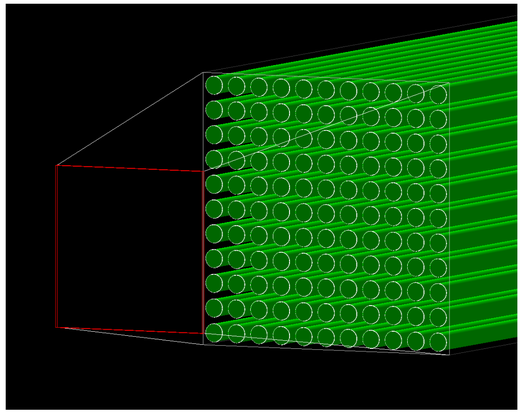


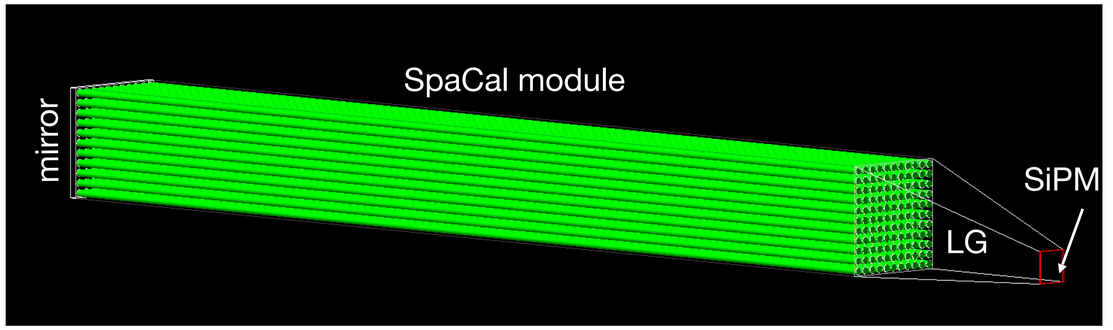


Geometry configurations

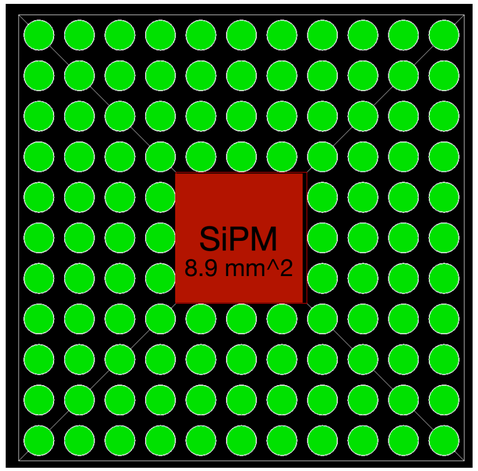
- Geometry 1.1

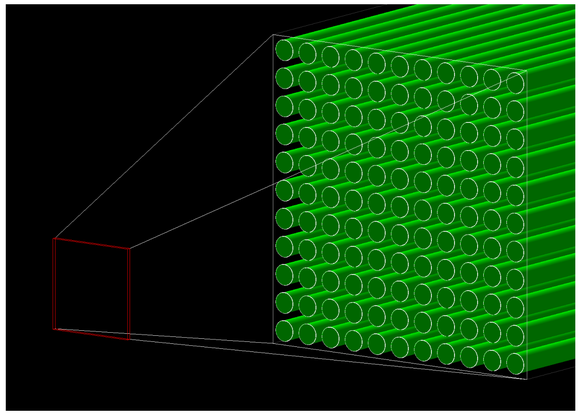




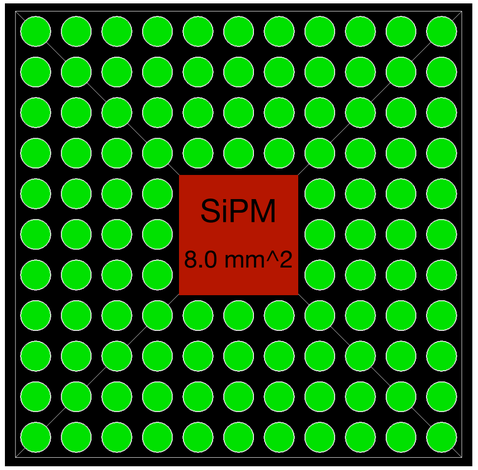


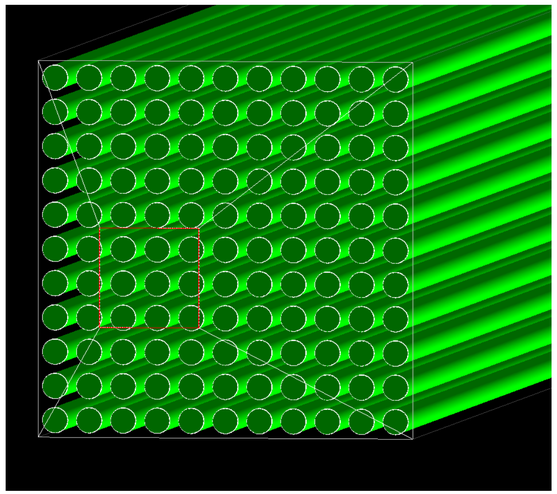
- Geometry 1.2





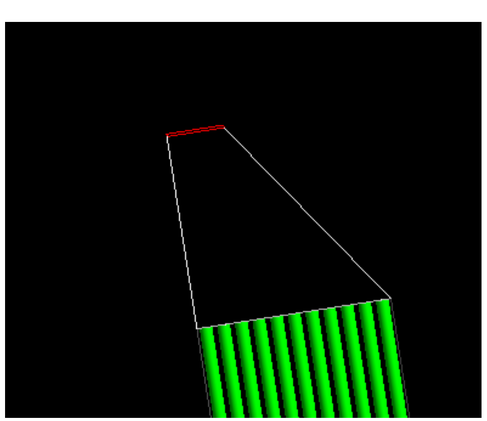
- Geometry 1.3 no results for now

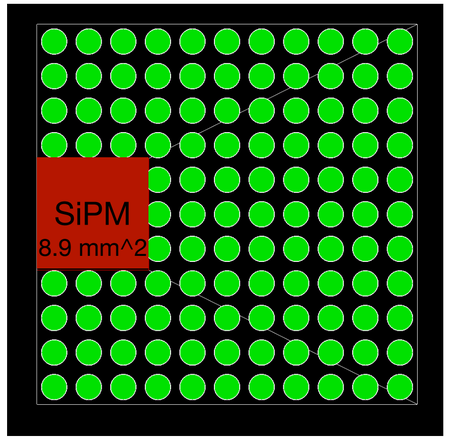




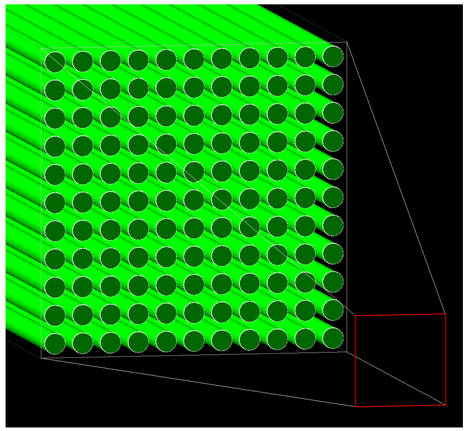
Geometry configurations

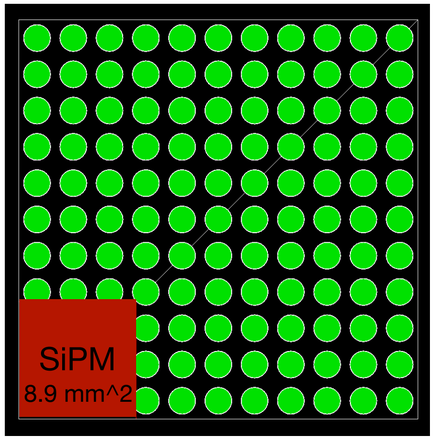
- Geometry 2





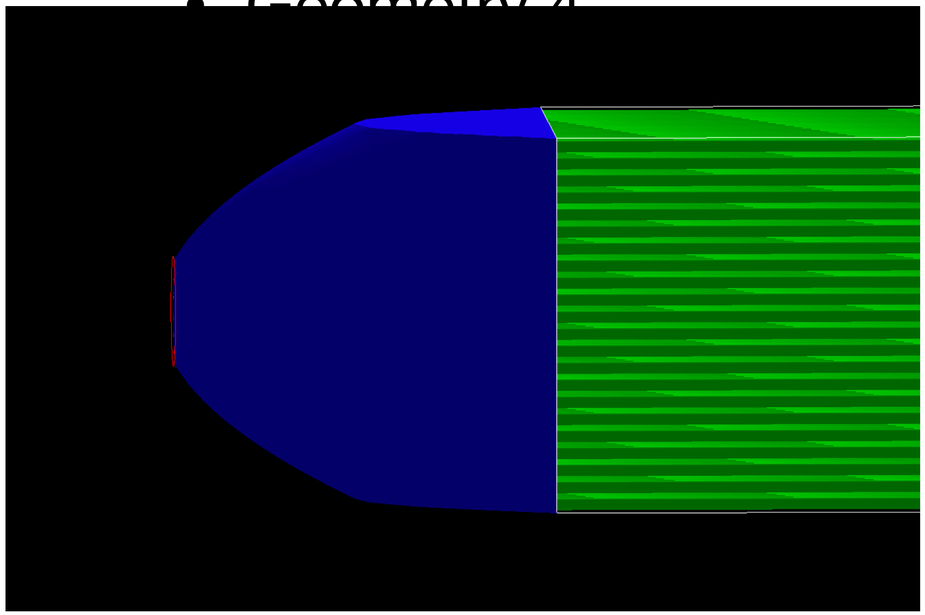
- Geometry 3





Geometry configurations

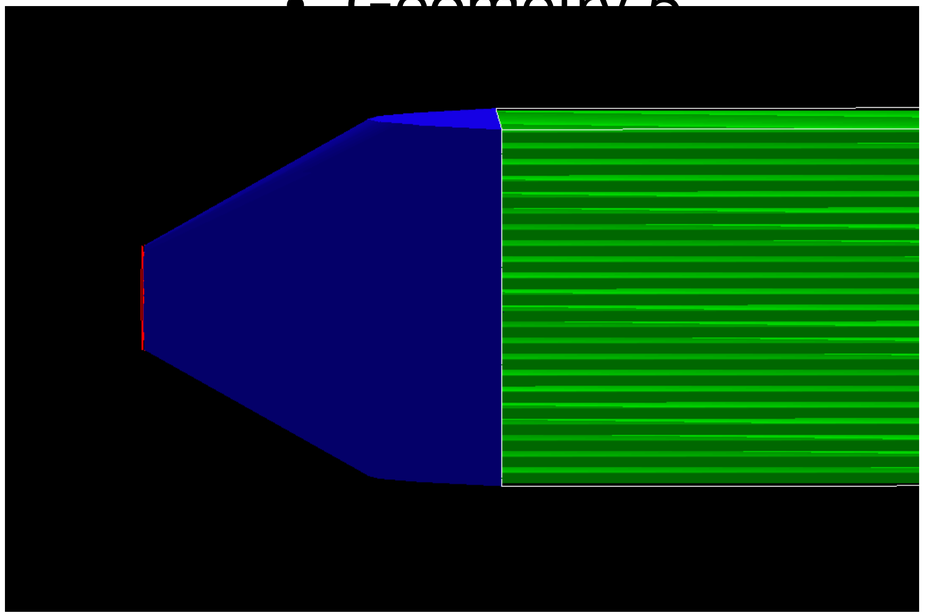
- Geometry 4



Winston Cone

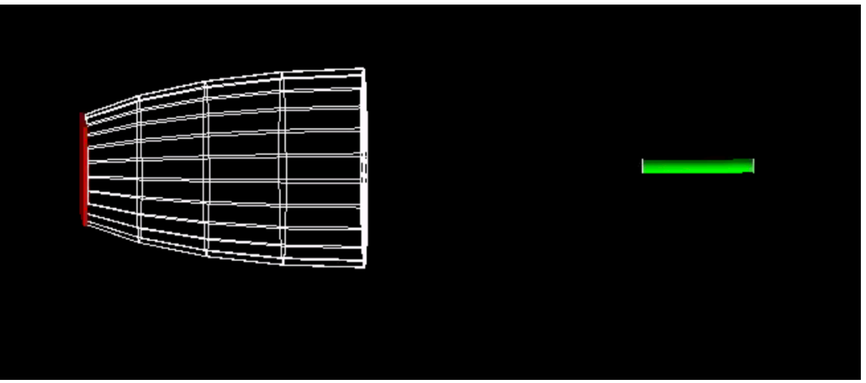
```
G4VSolid* coneS = new G4Paraboloid
("aPara",  0.5*PLEX_depth,PMT_radius,
0.5*sqrt(2)*(lguide_edge-2.0*airGap));
```

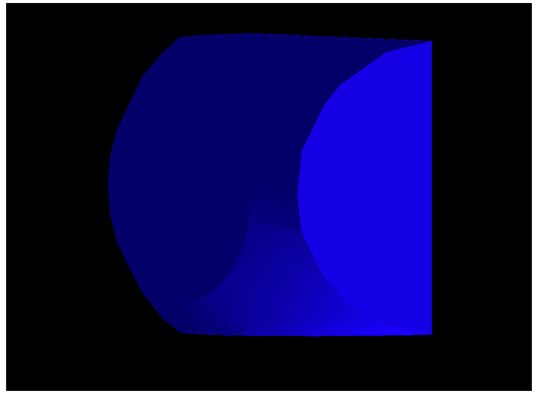
- Geometry 5

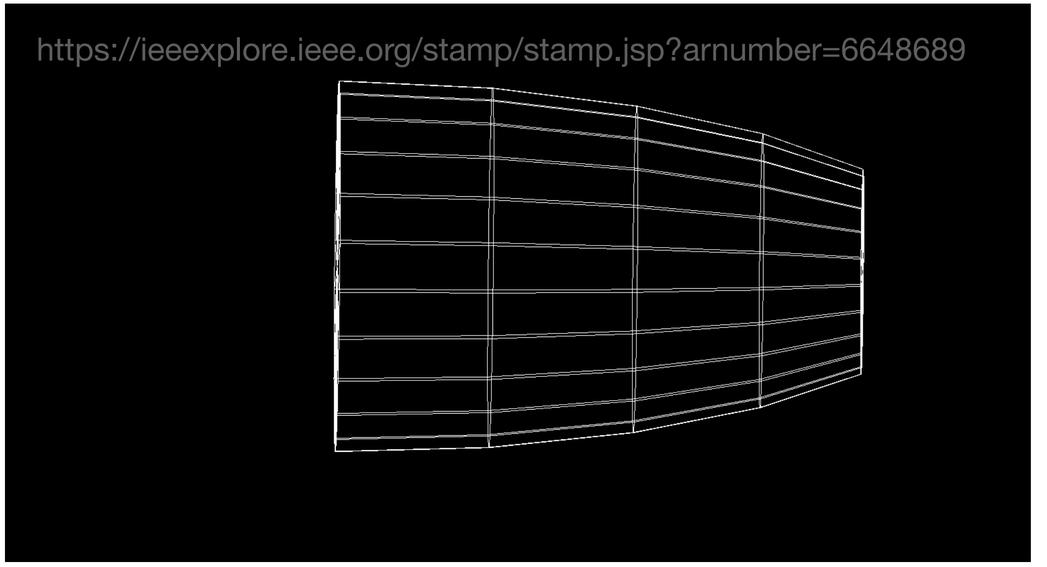


Fish Tail

```
G4VSolid* coneS = new G4Cons
("aCone",0,PMT_radius,0, 0.5*sqrt(2)*(lguide_edge-2.0*airGap) ,
0.5*PLEX_depth,0.0 * deg,360.0* deg);
```



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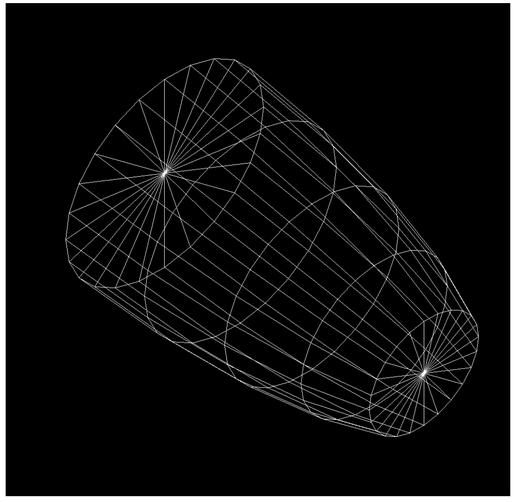
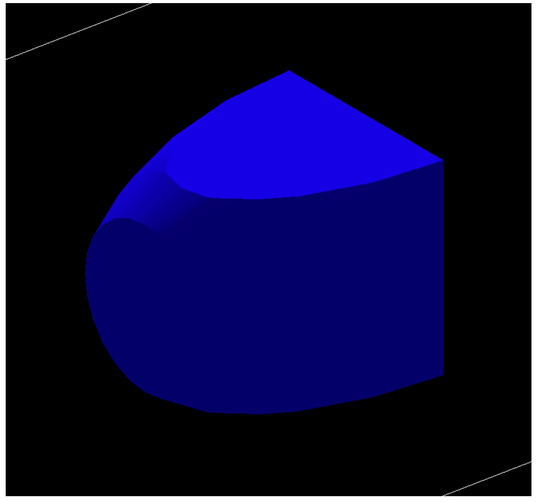
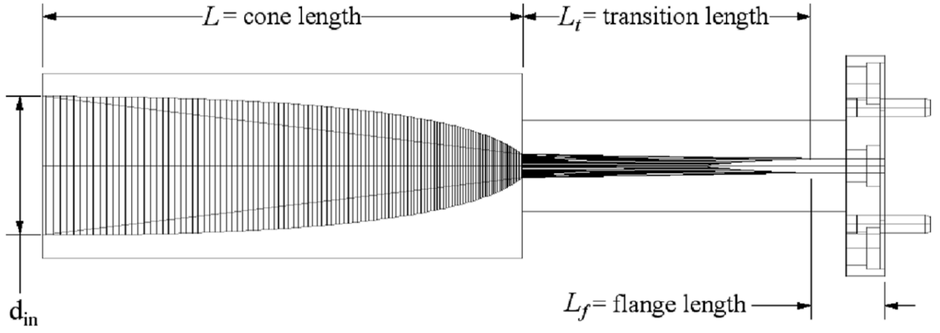
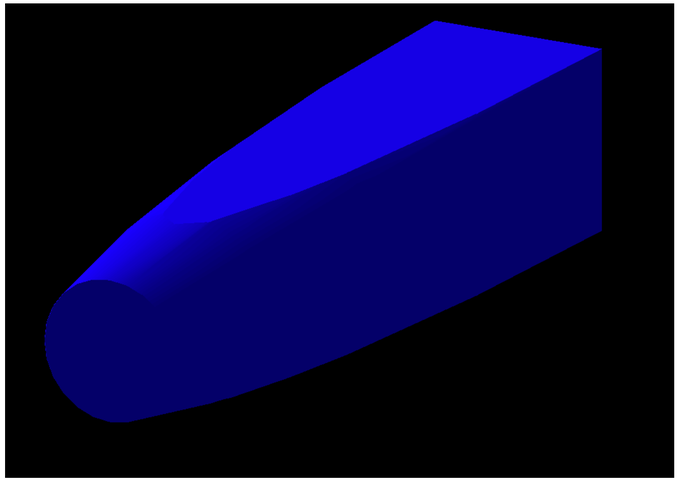
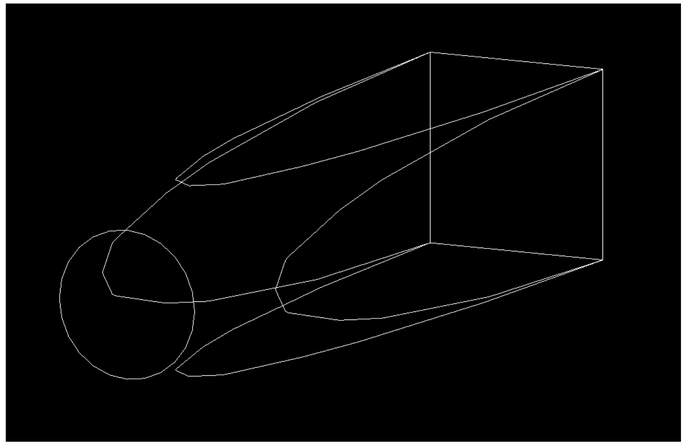
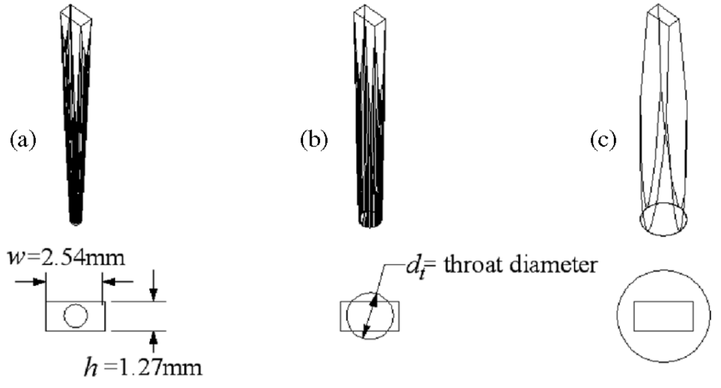





L = cone length
L_t = transition length
d_{in}
L_f = flange length



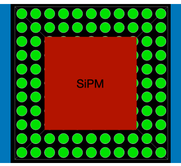



(a)
(b)
(c)
w=2.54mm
h =1.27mm
d_t= throat diameter

geometry 1.1

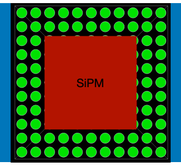
PMMA

Air



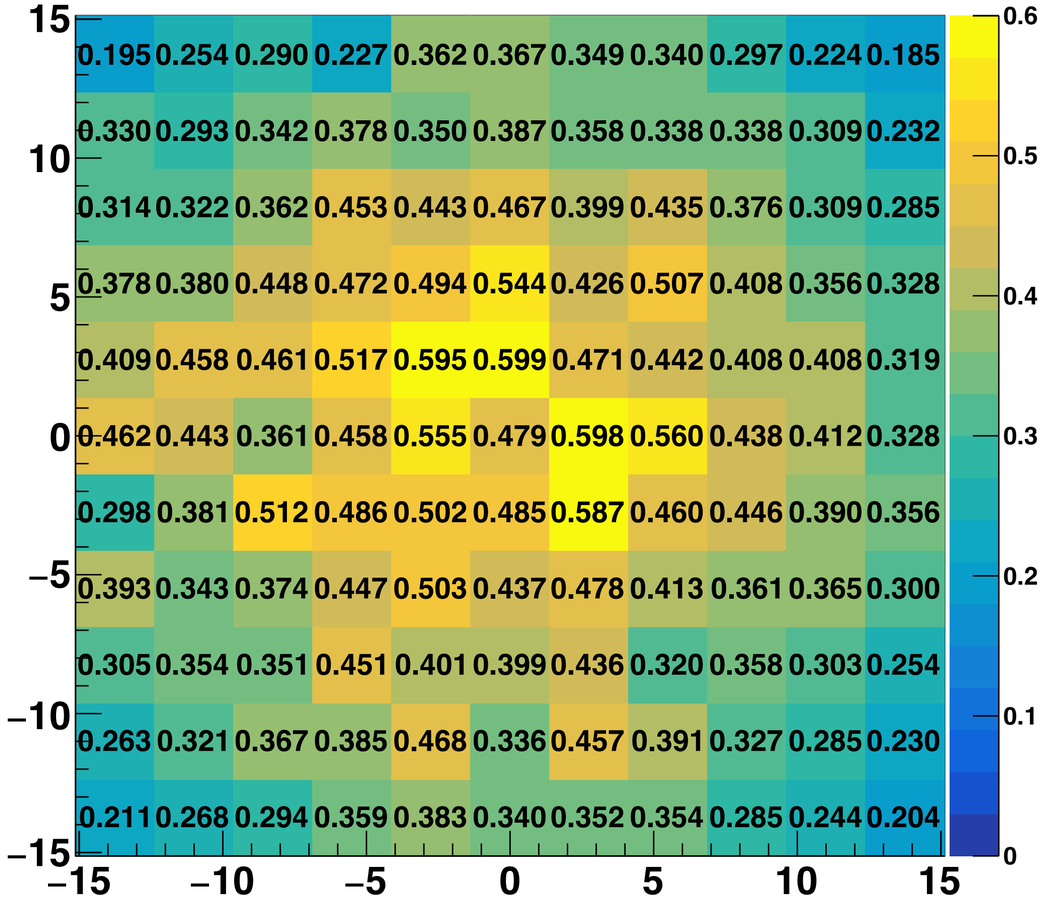
statistic 11.000 - muon 1 GeV

geometry 1.1 PMMA



statistic 11.000 - muon 1 GeV

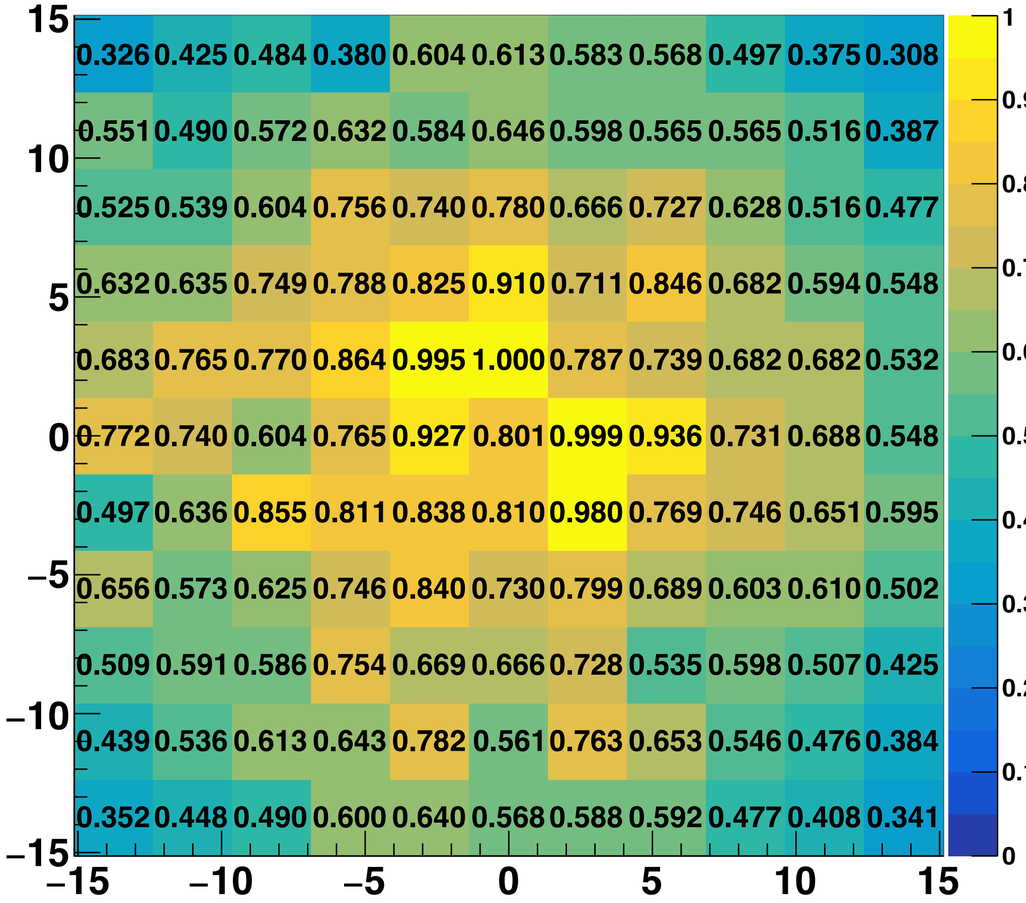
Efficiency - LG - PMMA - 2cm - base 18. mm



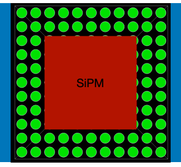
Factor non-uniformity - LG - PMMA - 2cm - base 18. mm

Standard deviation: 0.150

Mean value: 0.638

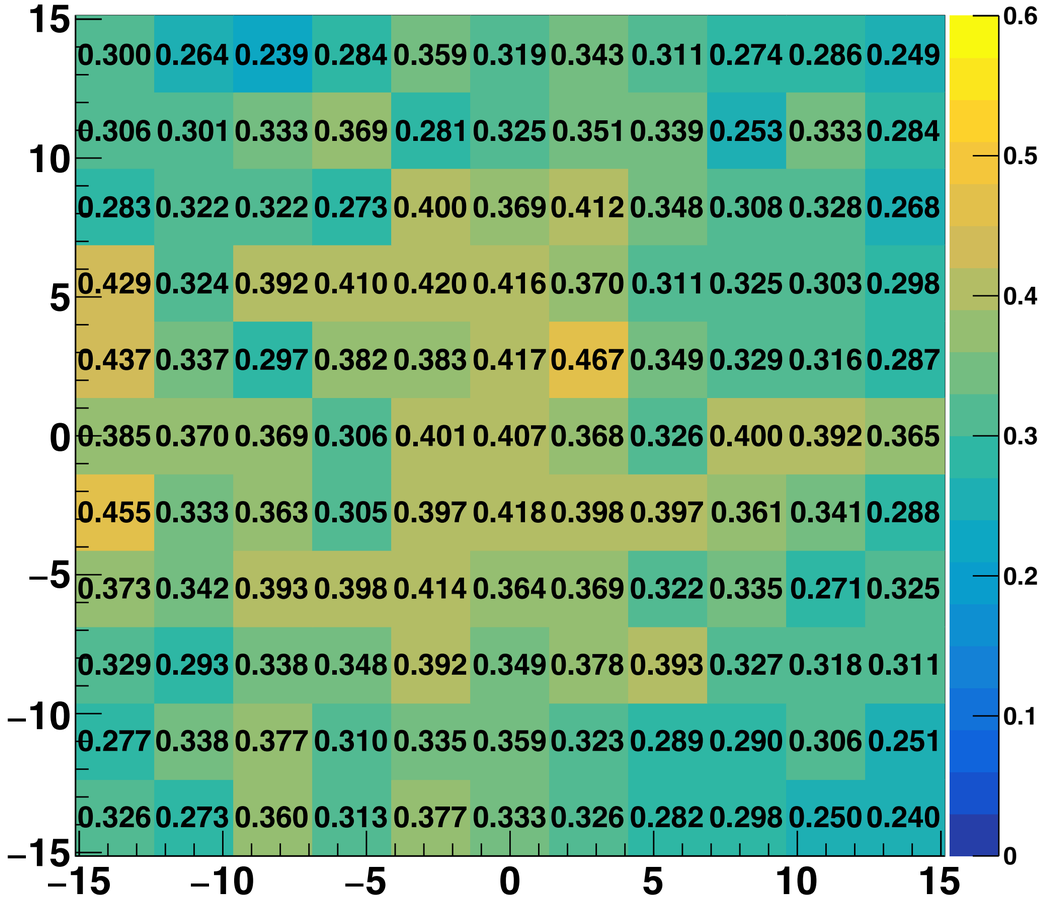


geometry 1.1 PMMA



statistic 11.000 - muon 1 GeV

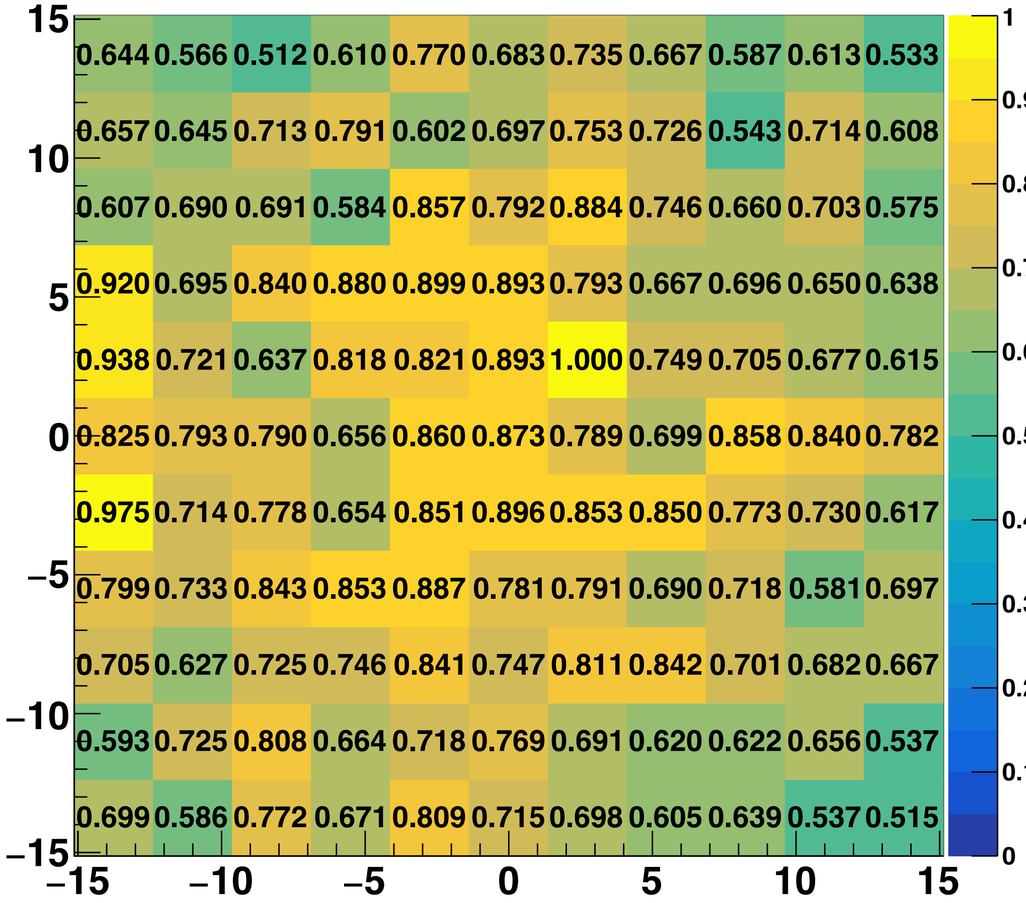
Efficiency - LG - PMMA - 3cm - base 18. mm



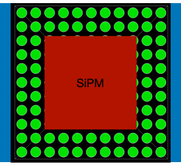
Factor non-uniformity - LG - PMMA - 3cm - base 18. mm

Standard deviation: 0.105

Mean value: 0.726

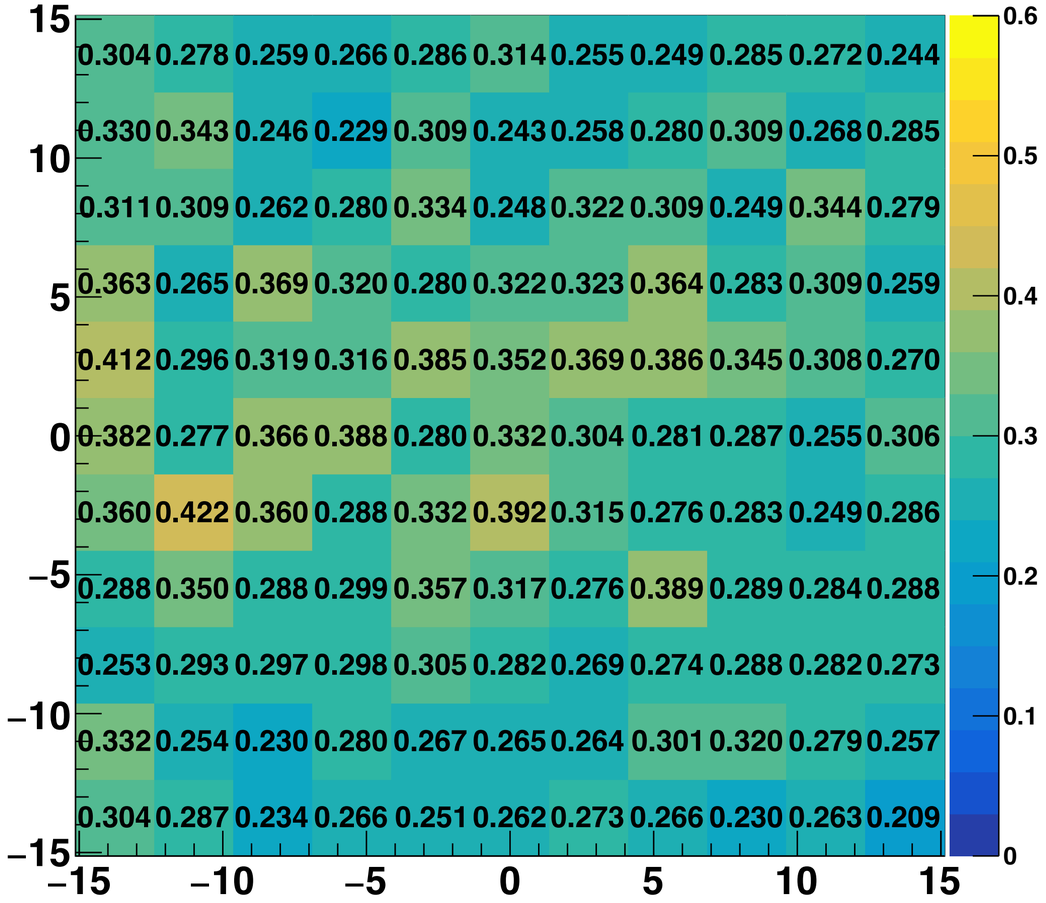


geometry 1.1 PMMA



statistic 11.000 - muon 1 GeV

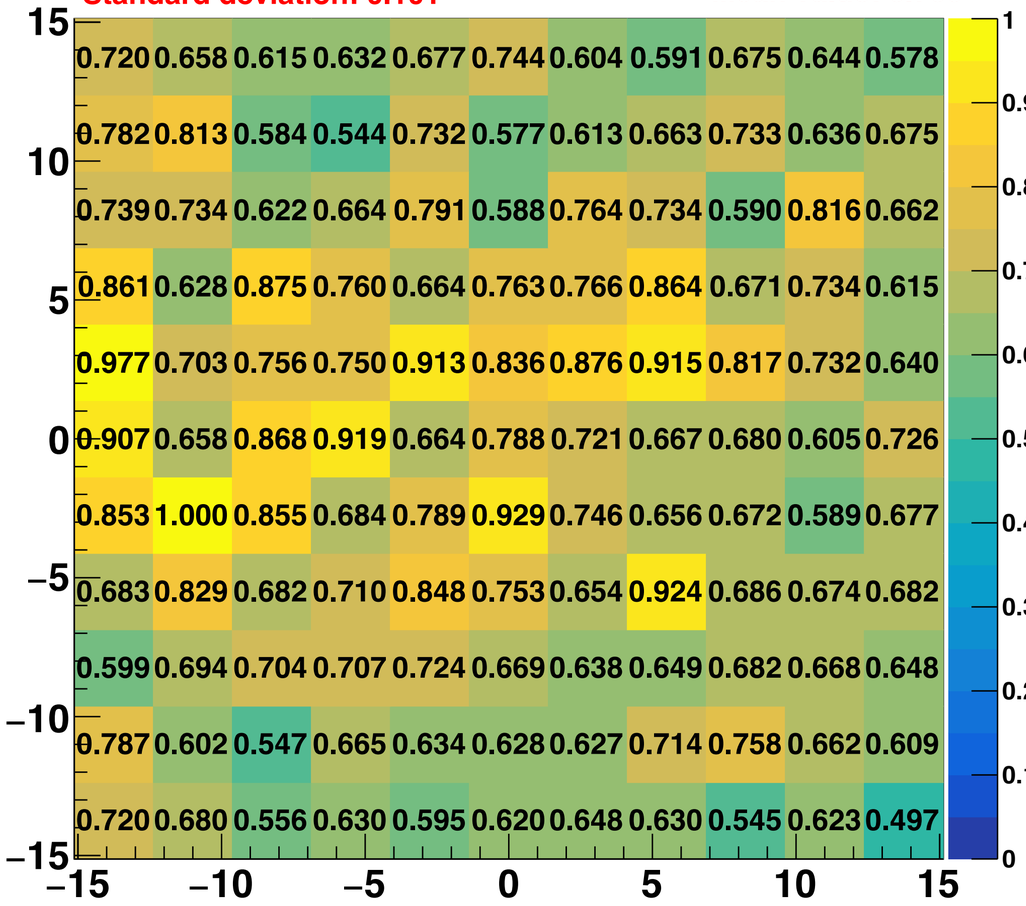
Efficiency - LG - PMMA - 4cm - base 18. mm



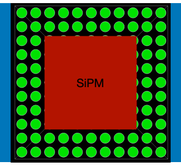
Factor non-uniformity - LG - PMMA - 4cm - base 18. mm

Standard deviation: 0.101

Mean value: 0.706

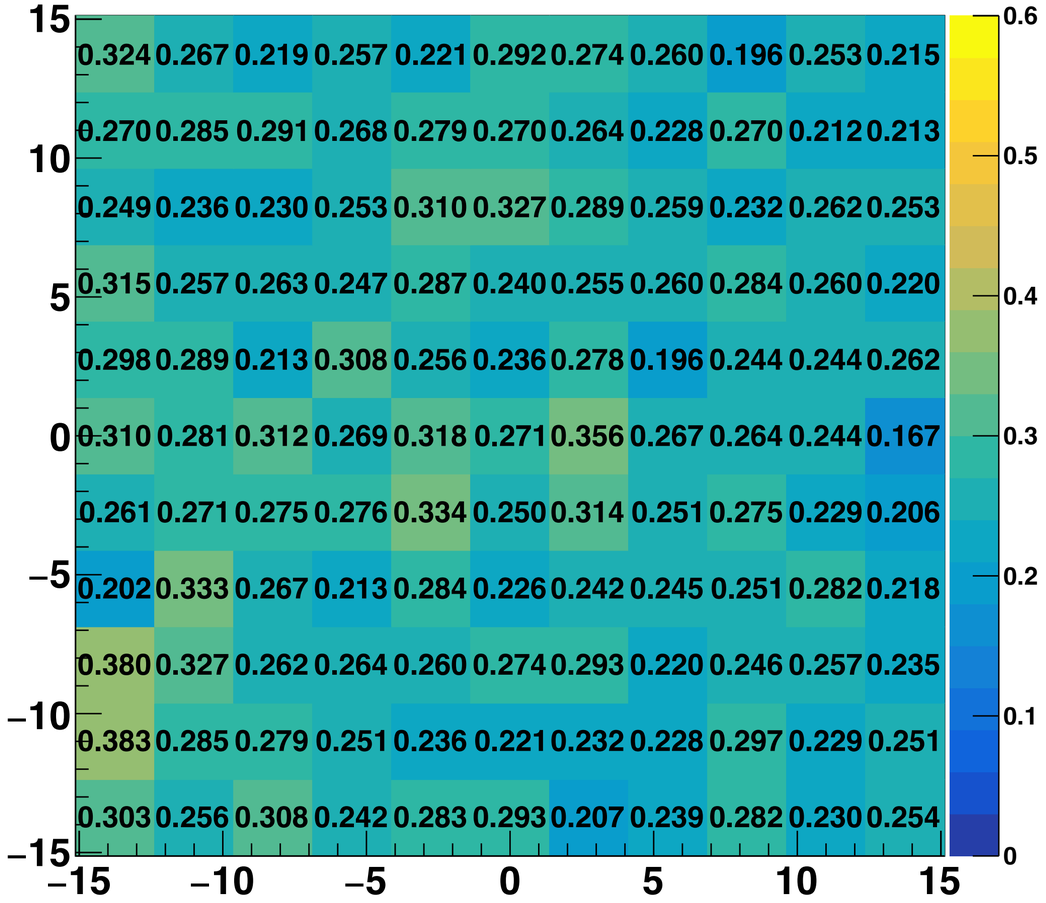


geometry 1.1 PMMA



statistic 11.000 - muon 1 GeV

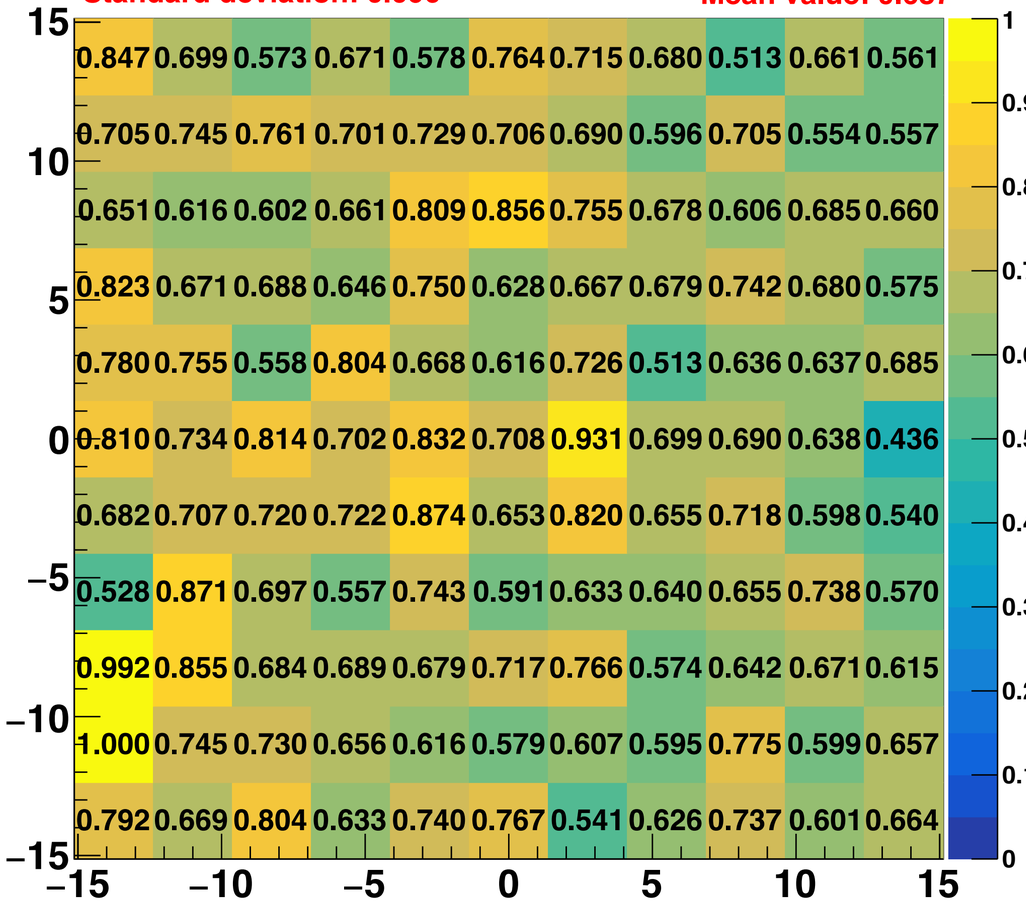
Efficiency - LG - PMMA - 5cm - base 18. mm



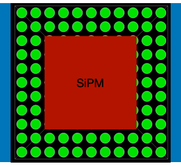
Factor non-uniformity - LG - PMMA - 5cm - base 18. mm

Standard deviation: 0.096

Mean value: 0.687

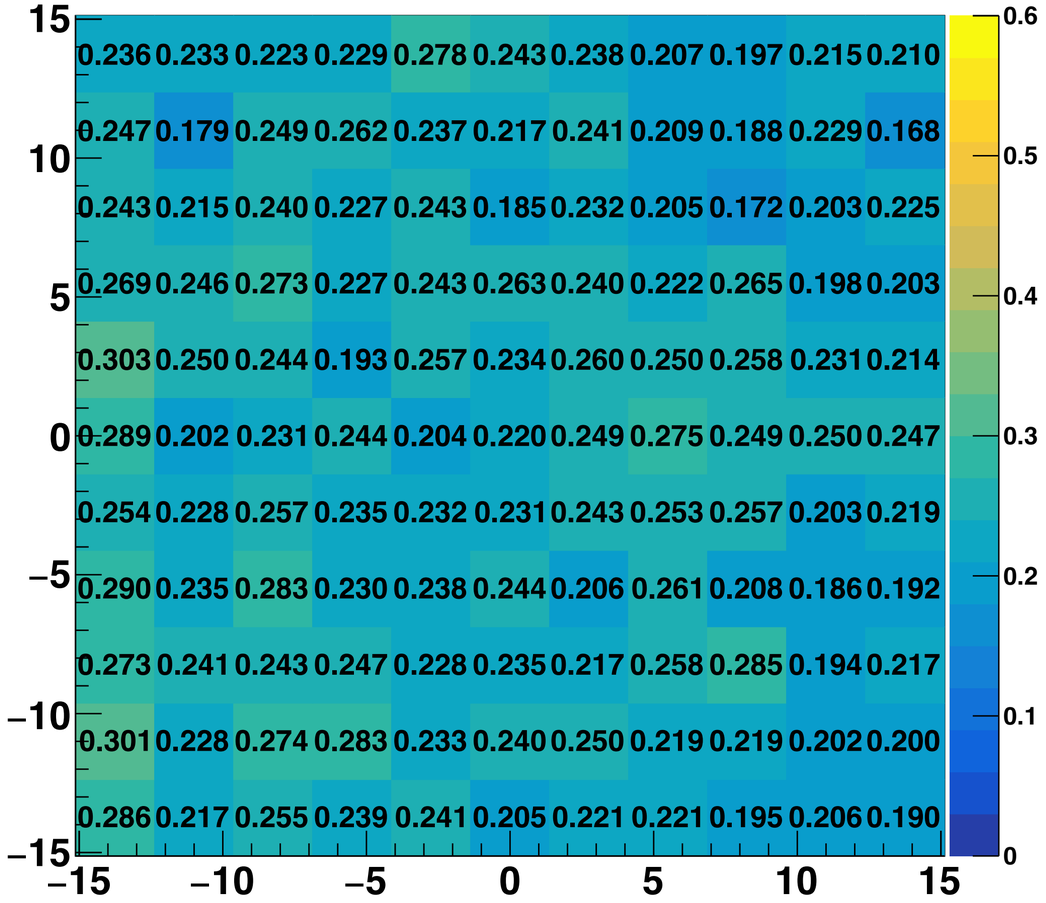


geometry 1.1 PMMA



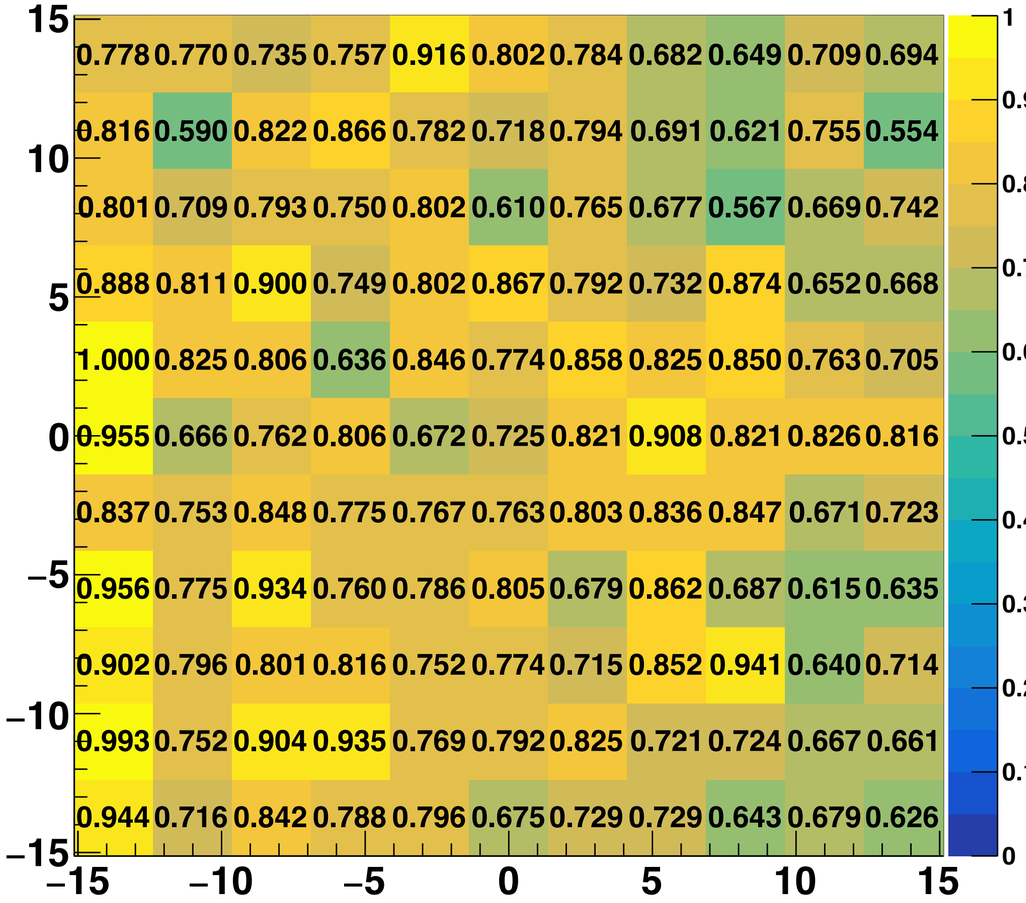
statistic 11.000 - muon 1 GeV

Efficiency - LG - PMMA - 6cm - base 18. mm

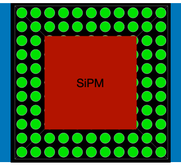


Factor non-uniformity - LG - PMMA - 6cm - base 18. mm

Standard deviation: 0.091 **Mean value: 0.771**

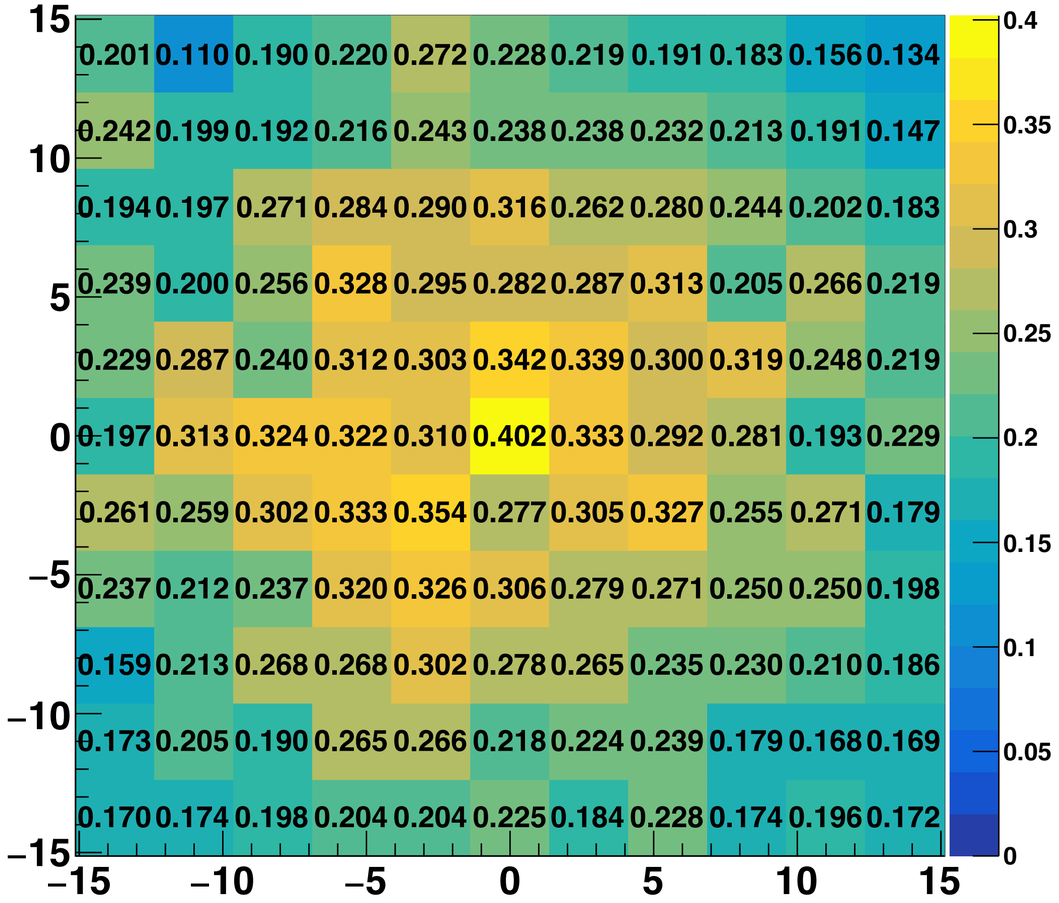


geometry 1.1 AIR



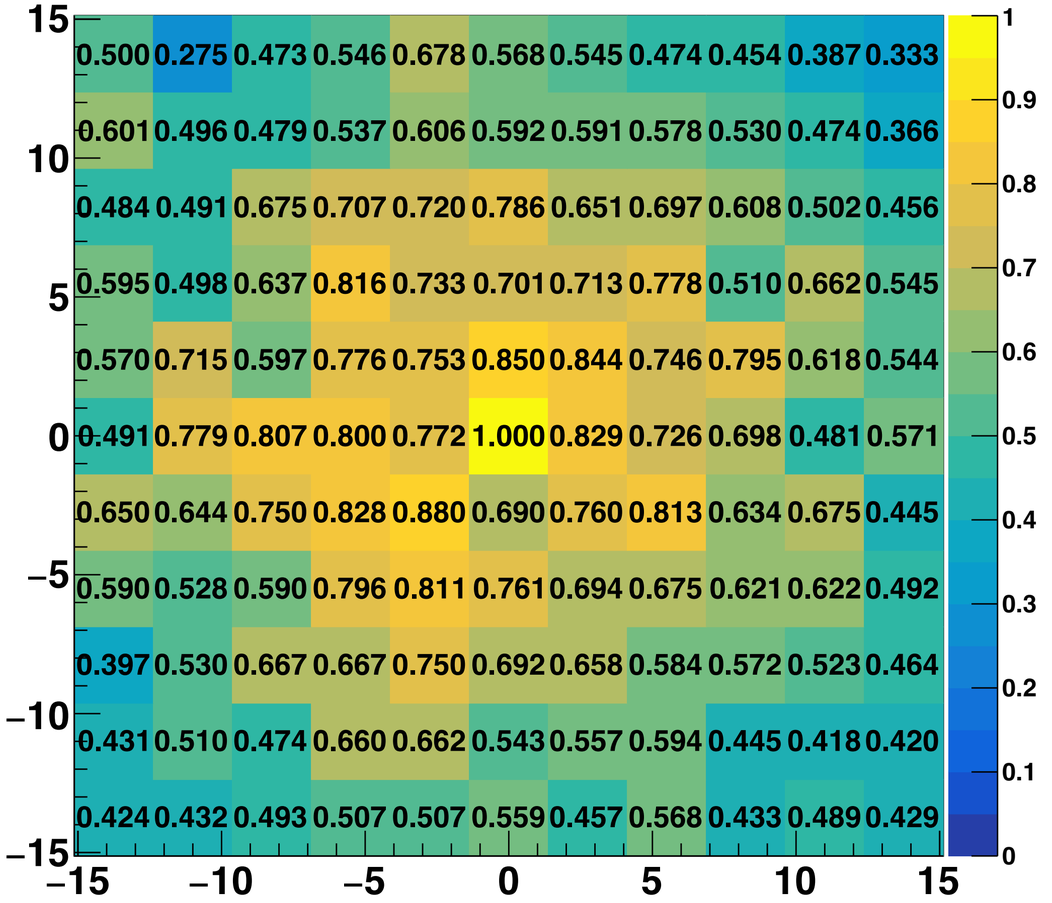
statistic 11.000 - muon 1 GeV

Efficiency - LG - Air - 2cm - base 18. mm

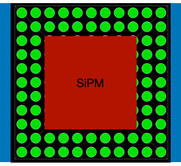


Factor non-uniformity - LG - AIR - 2cm - base 18. mm

Standard deviation: 0.135 **Mean value: 0.606**

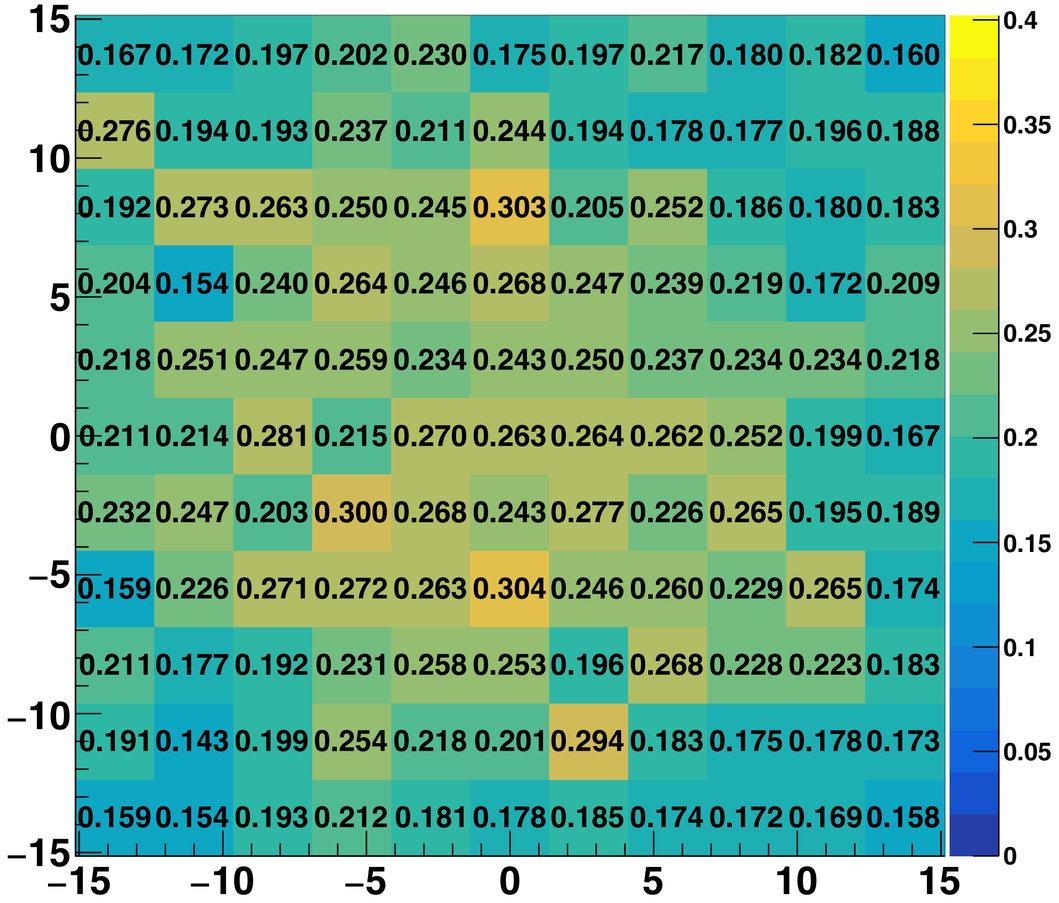


geometry 1.1 AIR



statistic 11.000 - muon 1 GeV

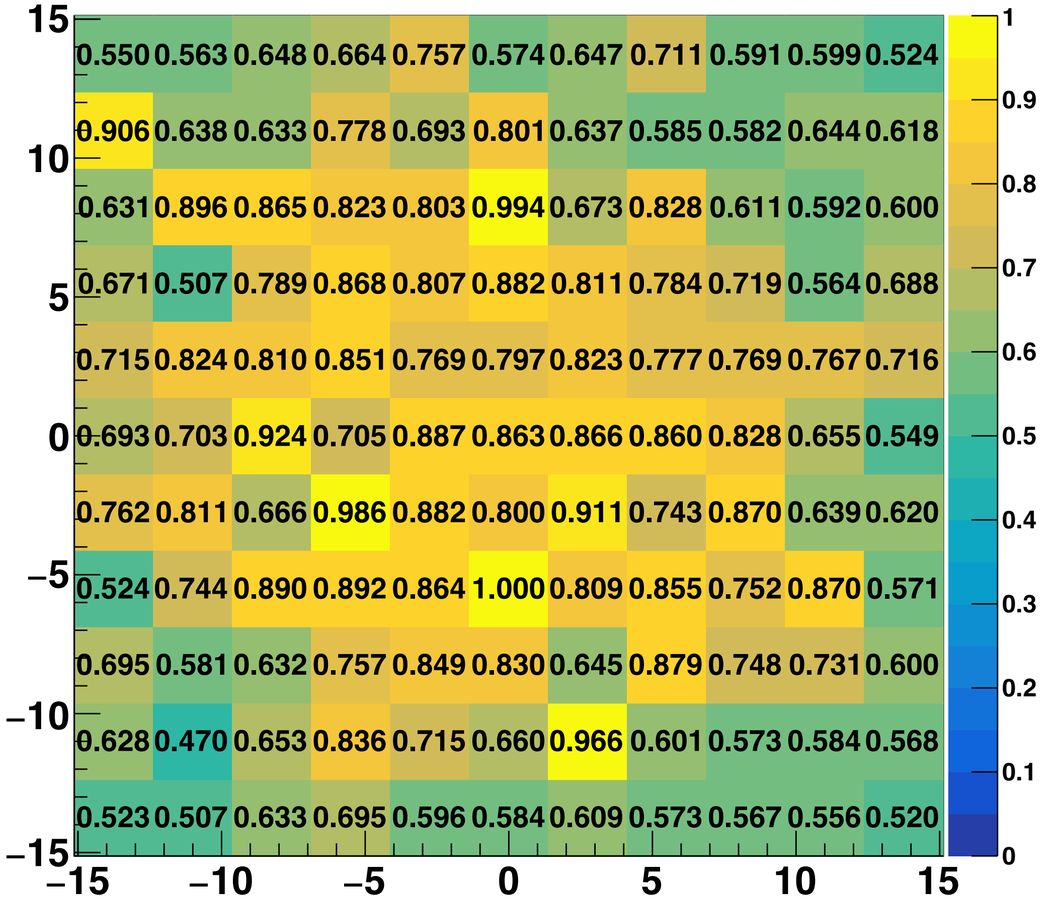
Efficiency - LG - Air - 3cm - base 18. mm



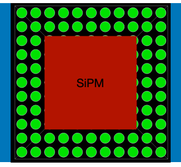
Factor non-uniformity - LG - AIR - 3cm - base 18. mm

Standard deviation: 0.126

Mean value: 0.718

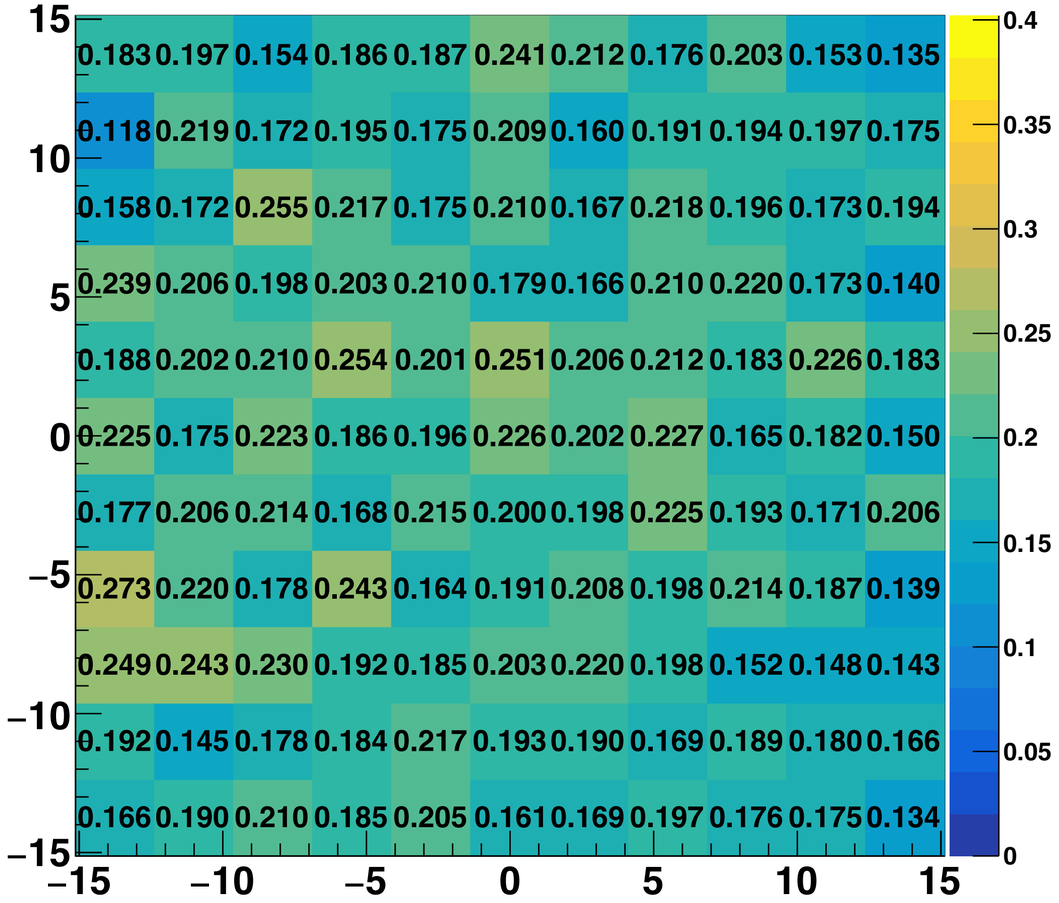


geometry 1.1 AIR



statistic 11.000 - muon 1 GeV

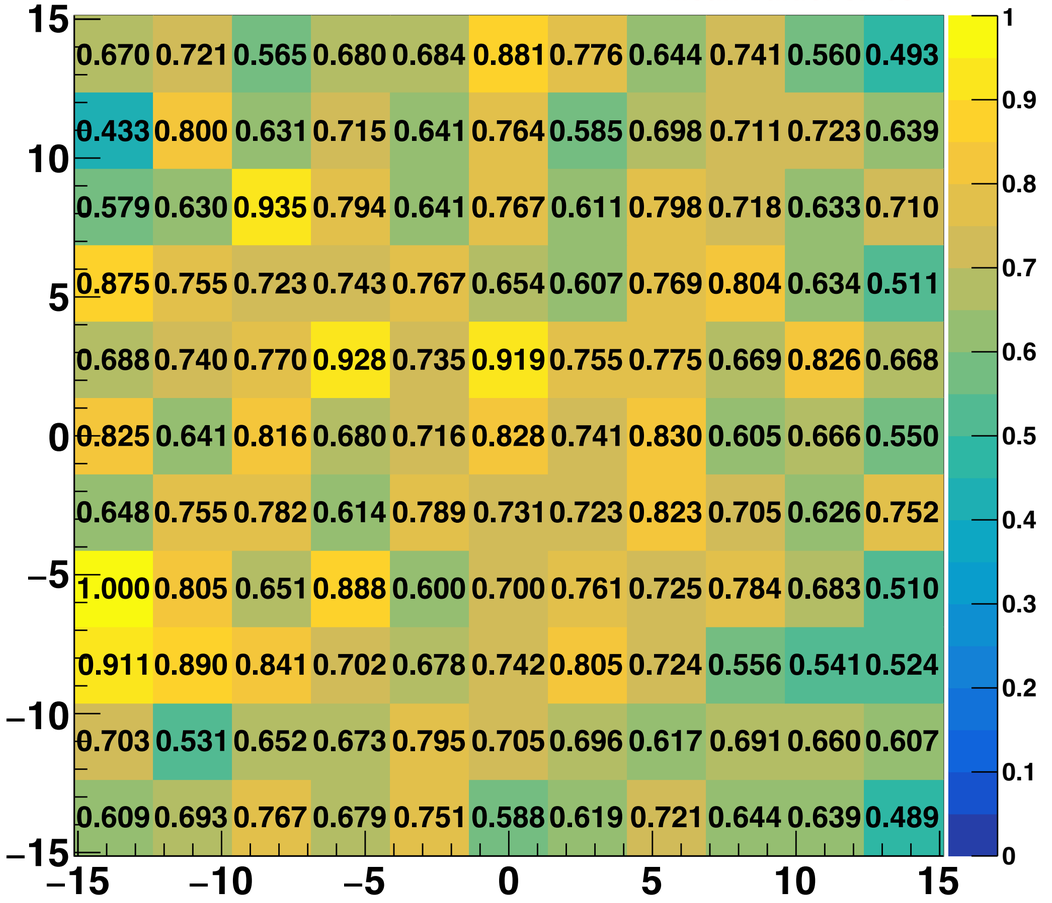
Efficiency - LG - Air - 4cm - base 18. mm



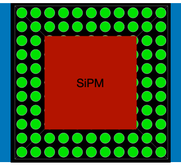
Factor non-uniformity - LG - AIR - 4cm - base 18. mm

Standard deviation: 0.103

Mean value: 0.705

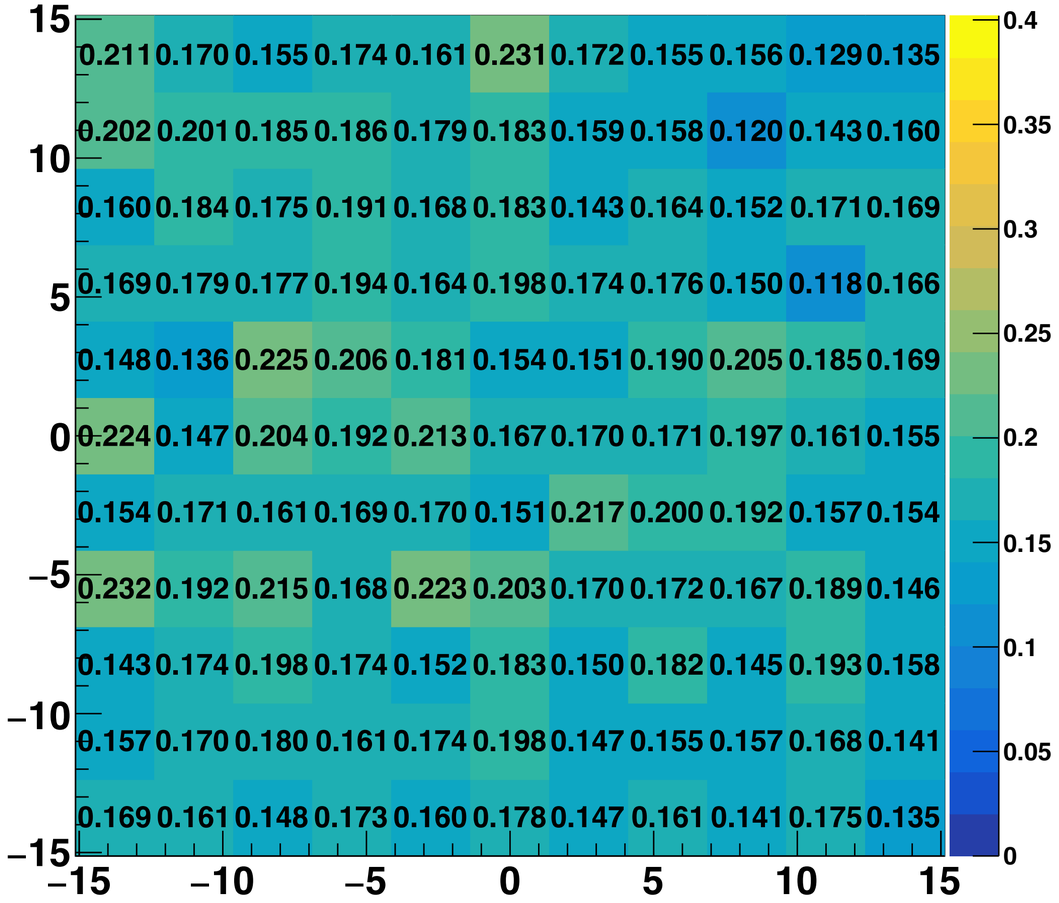


geometry 1.1 AIR



statistic 11.000 - muon 1 GeV

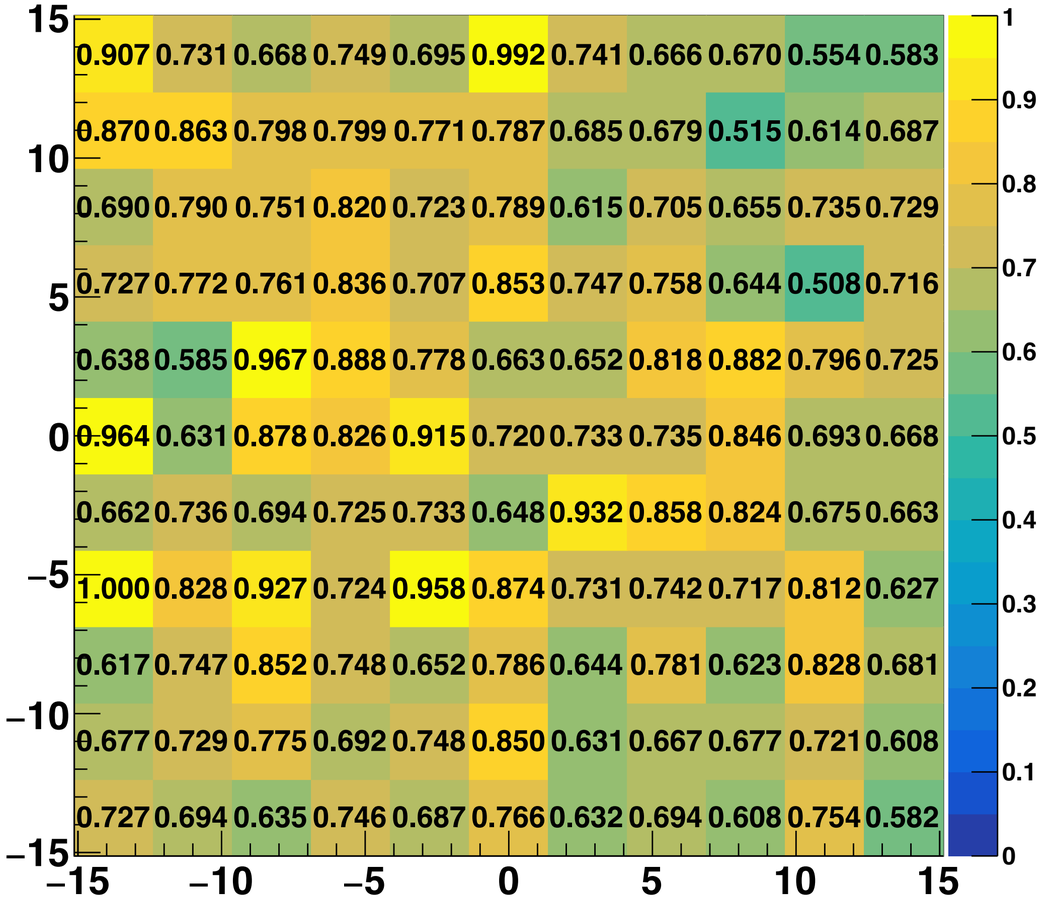
Efficiency - LG - Air - 5cm - base 18. mm



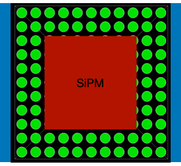
Factor non-uniformity - LG - AIR - 5cm - base 18. mm

Standard deviation: 0.099

Mean value: 0.739

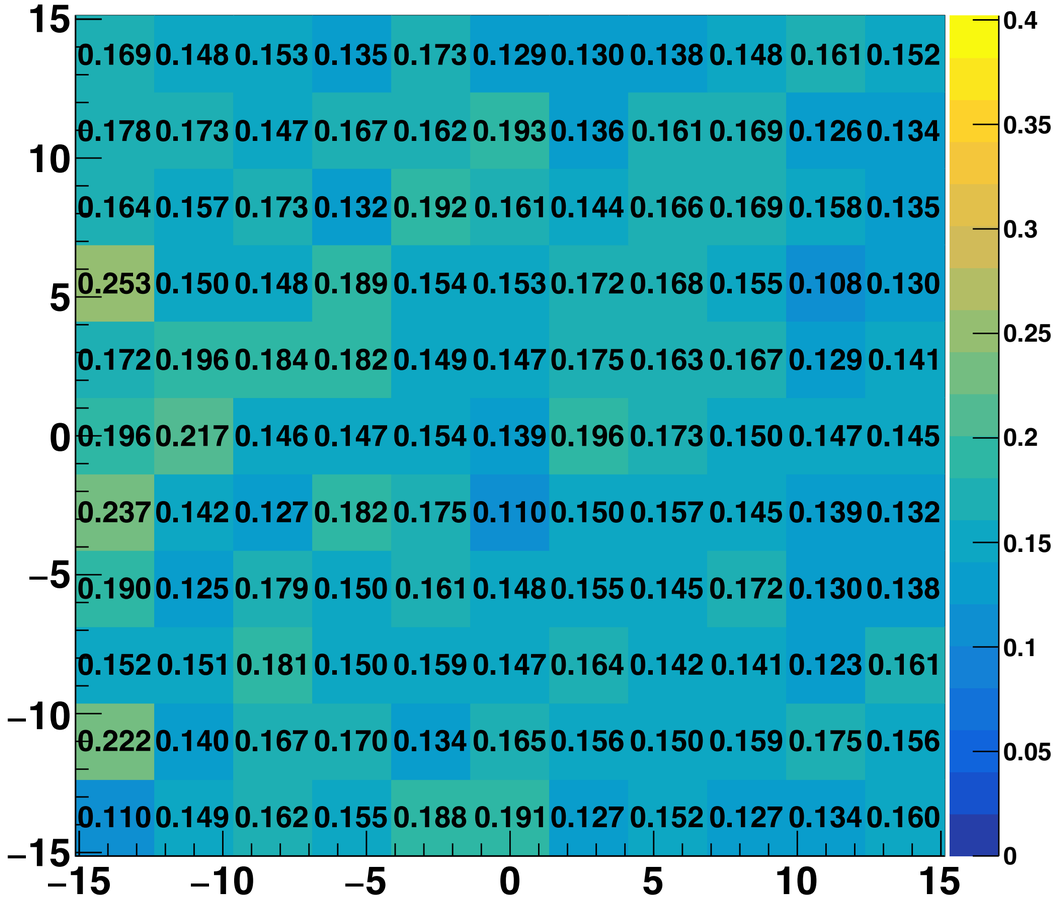


geometry 1.1 AIR



statistic 11.000 - muon 1 GeV

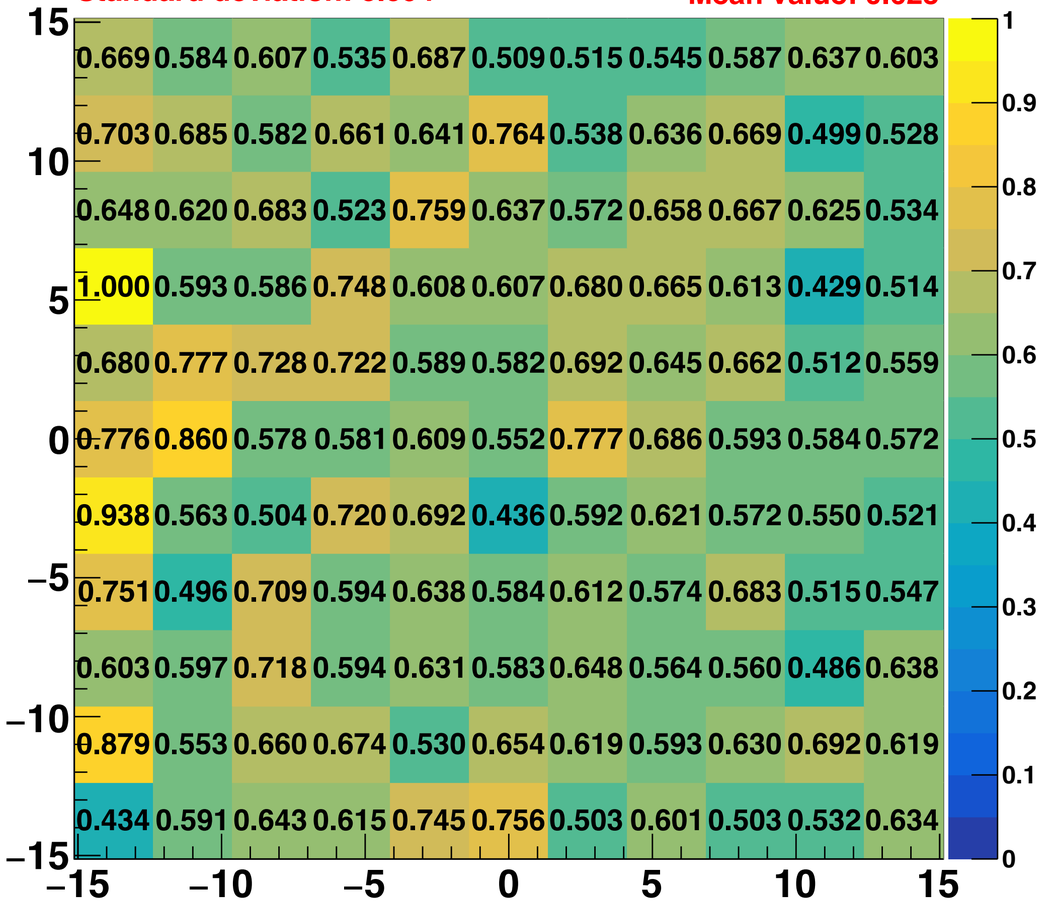
Efficiency - LG - Air - 6cm - base 18. mm

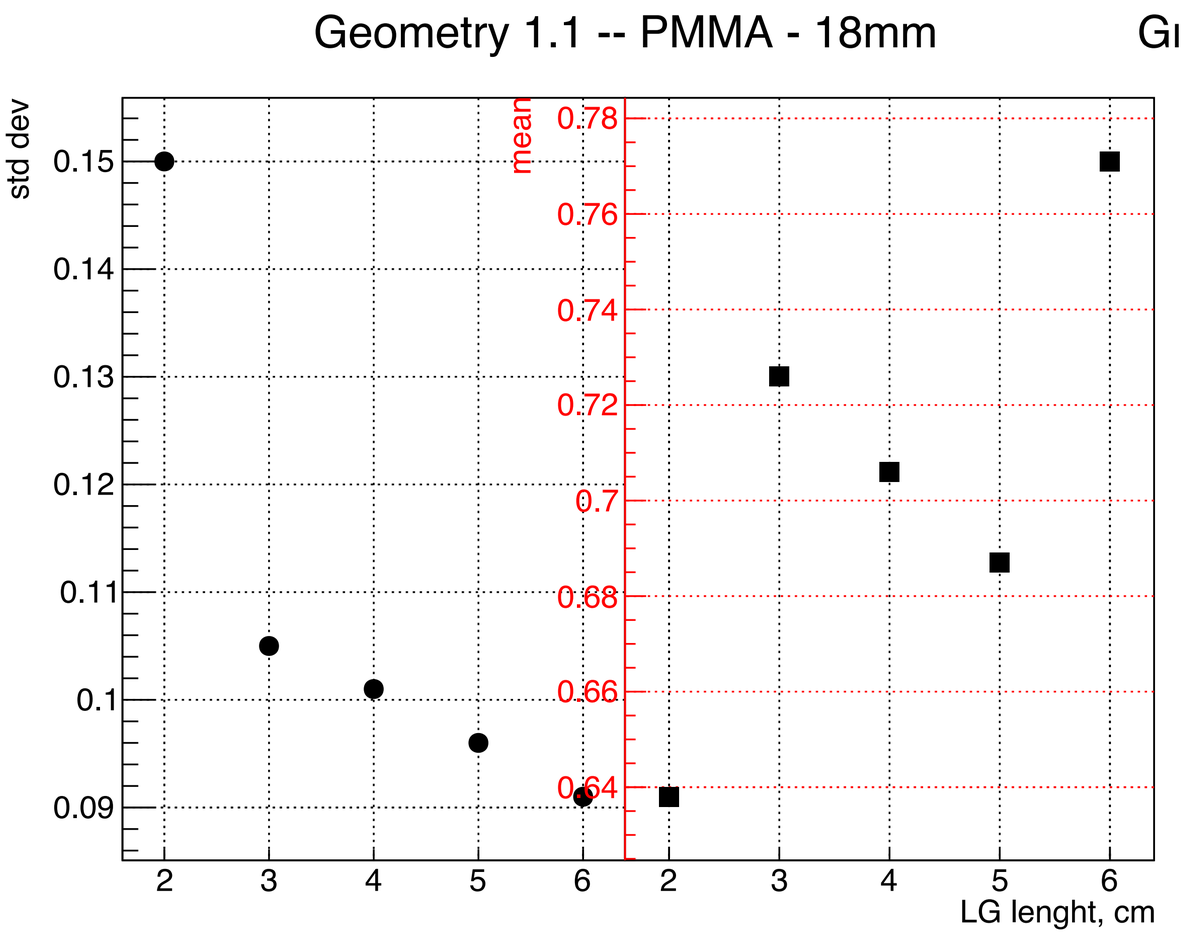


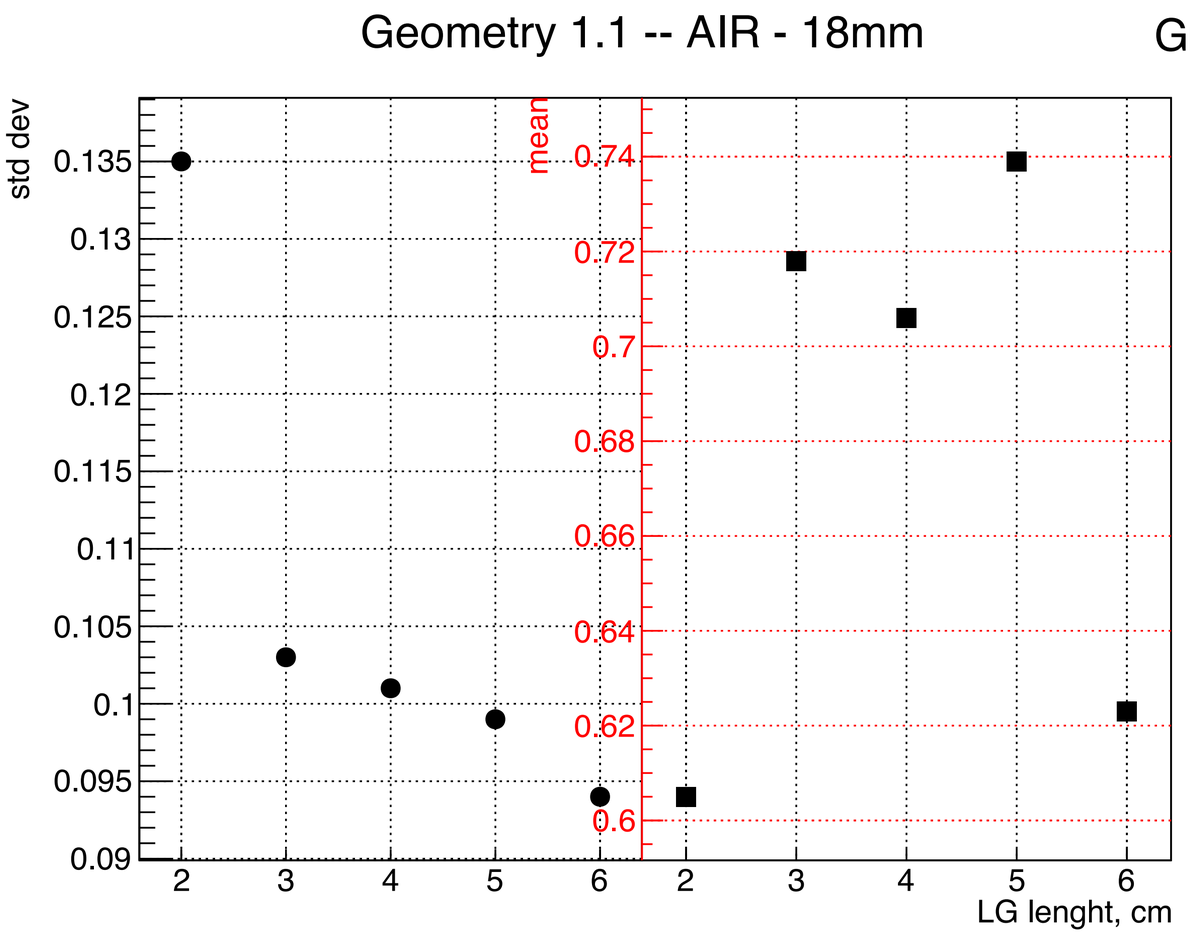
Factor non-uniformity - LG - AIR - 6cm - base 18. mm

Standard deviation: 0.094

Mean value: 0.623



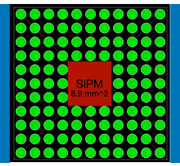

Geometry 1.1 -- PMMA - 18mm
std dev
mean
LG lenght, cm


Geometry 1.1 -- AIR - 18mm
std dev
mean
LG lenght, cm

geometry 1.2

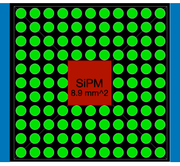
PMMA

Air



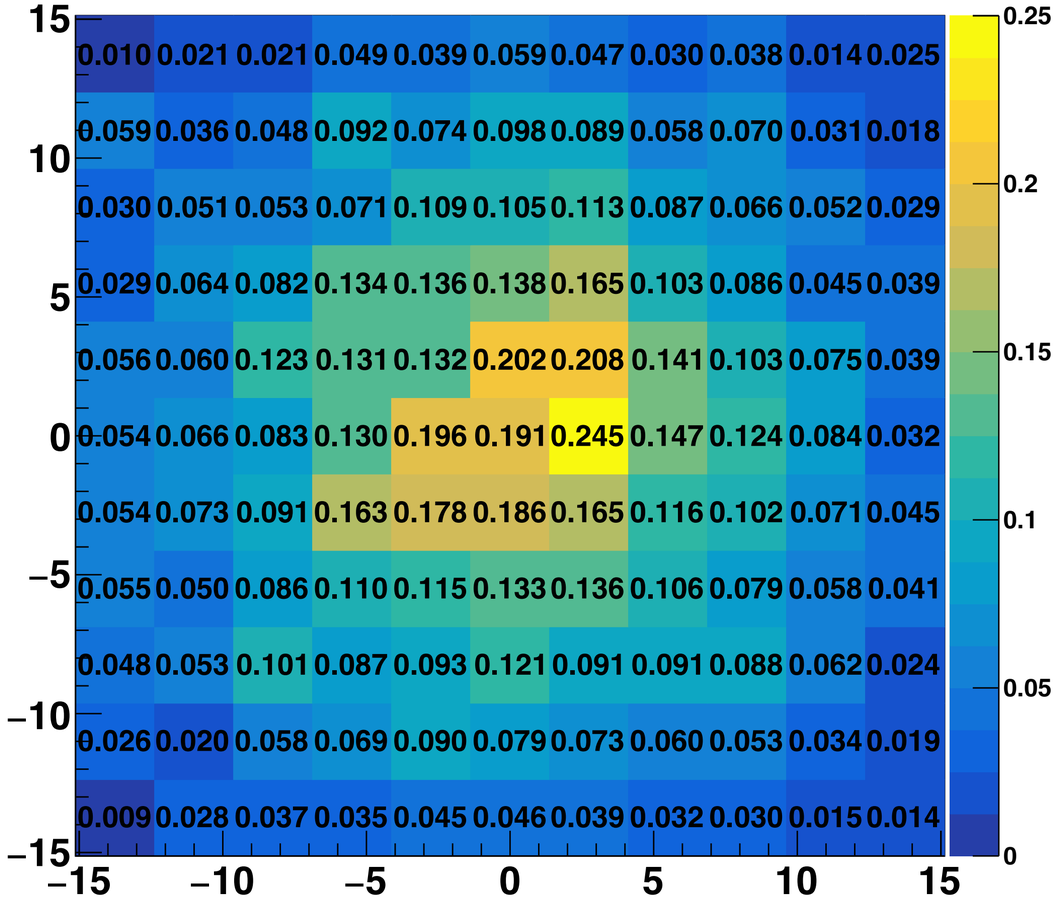
statistic 11.000 - muon 1 GeV

geometry 1.2 PMMA



statistic 11.000 - muon 1 GeV

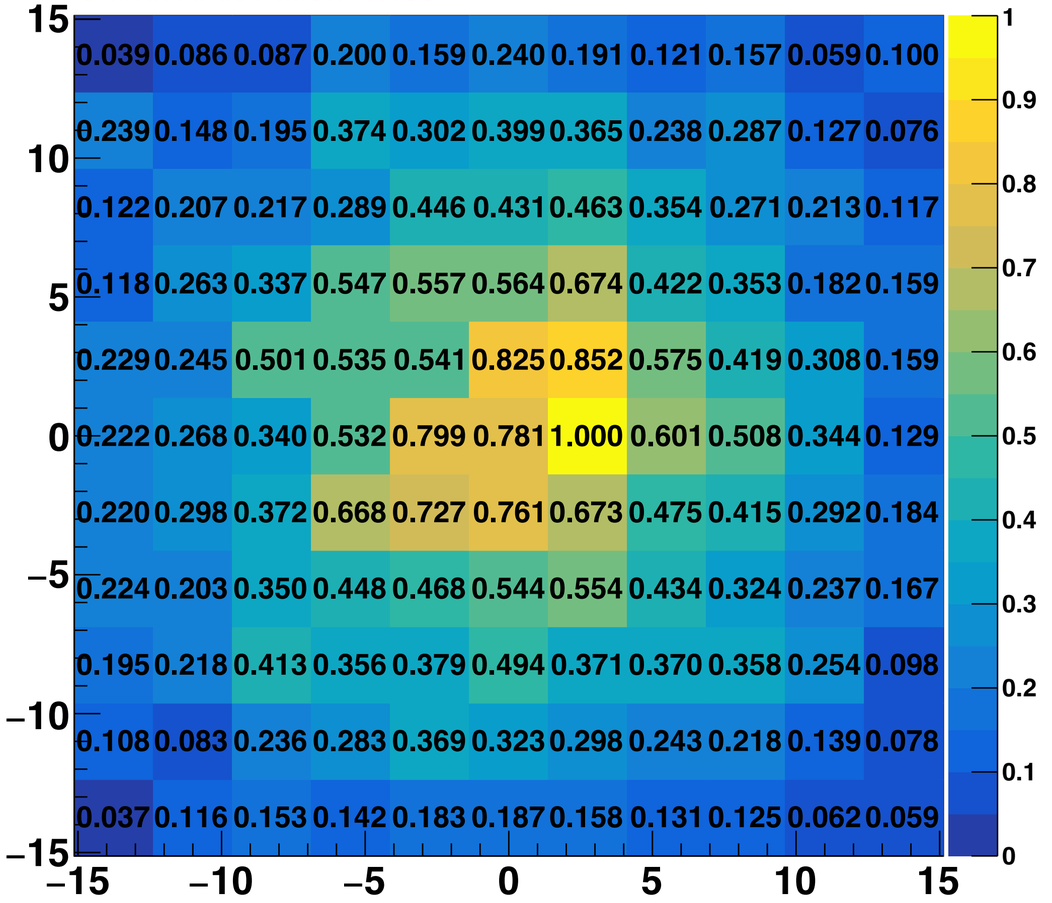
Efficiency - LG - PMMA - 2cm - base 8.9 mm



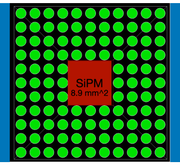
Factor non-uniformity - LG - PMMA - 2cm - base 8.9 mm

Standard deviation: 0.198

Mean value: 0.318

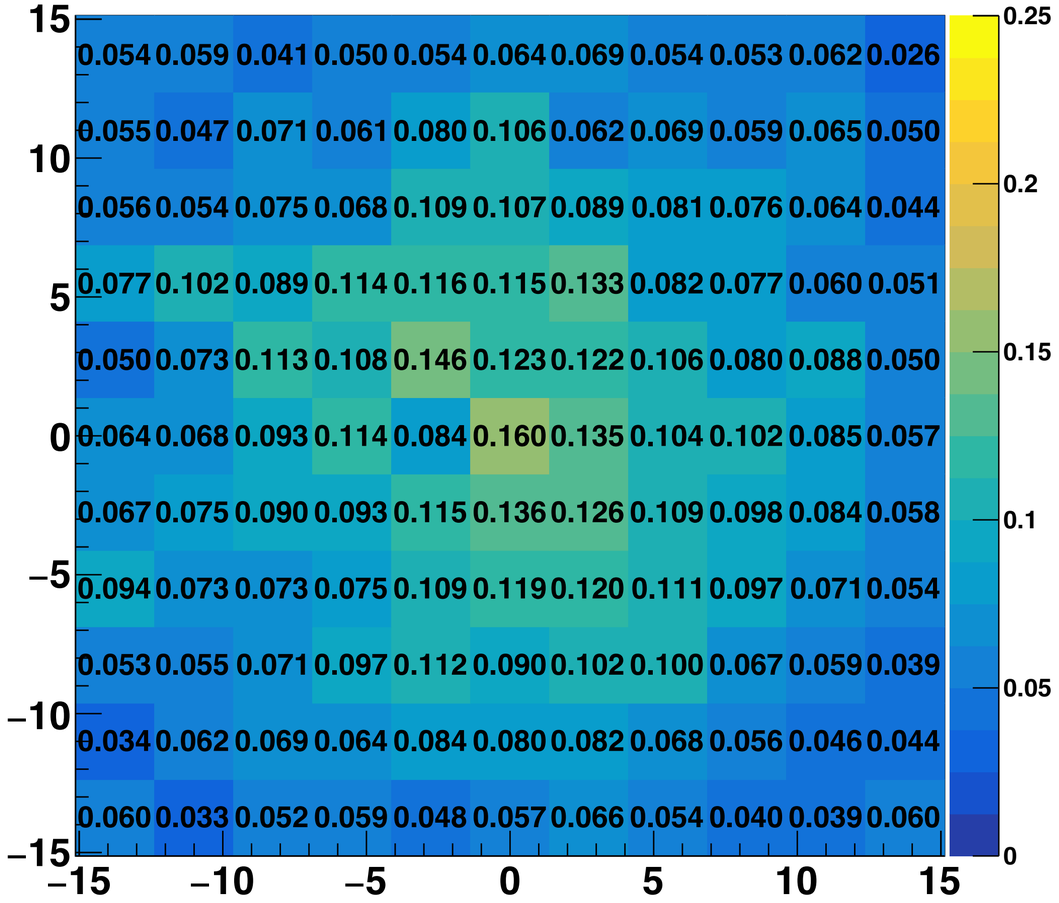


geometry 1.2 PMMA



statistic 11.000 - muon 1 GeV

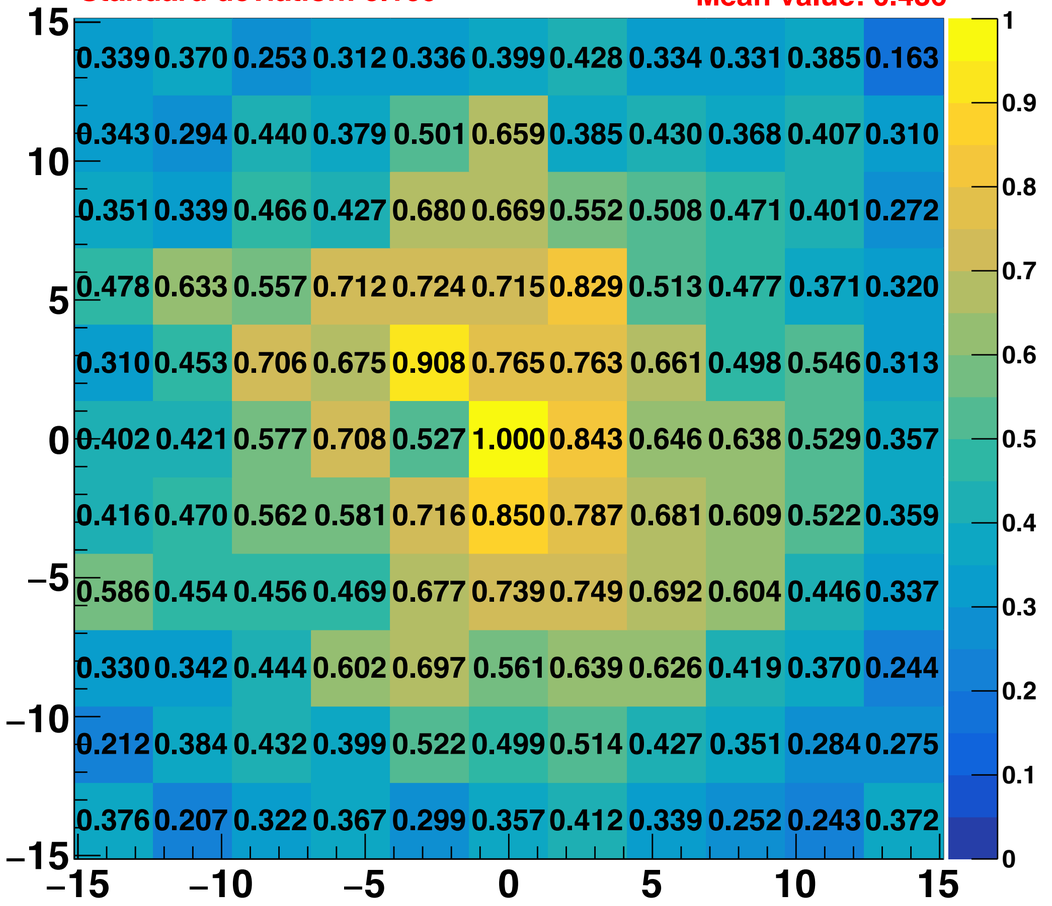
Efficiency - LG - PMMA - 3cm - base 8.9 mm



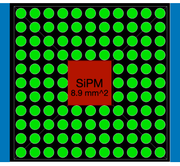
Factor non-uniformity - LG - PMMA - 3cm - base 8.9 mm

Standard deviation: 0.169

Mean value: 0.486

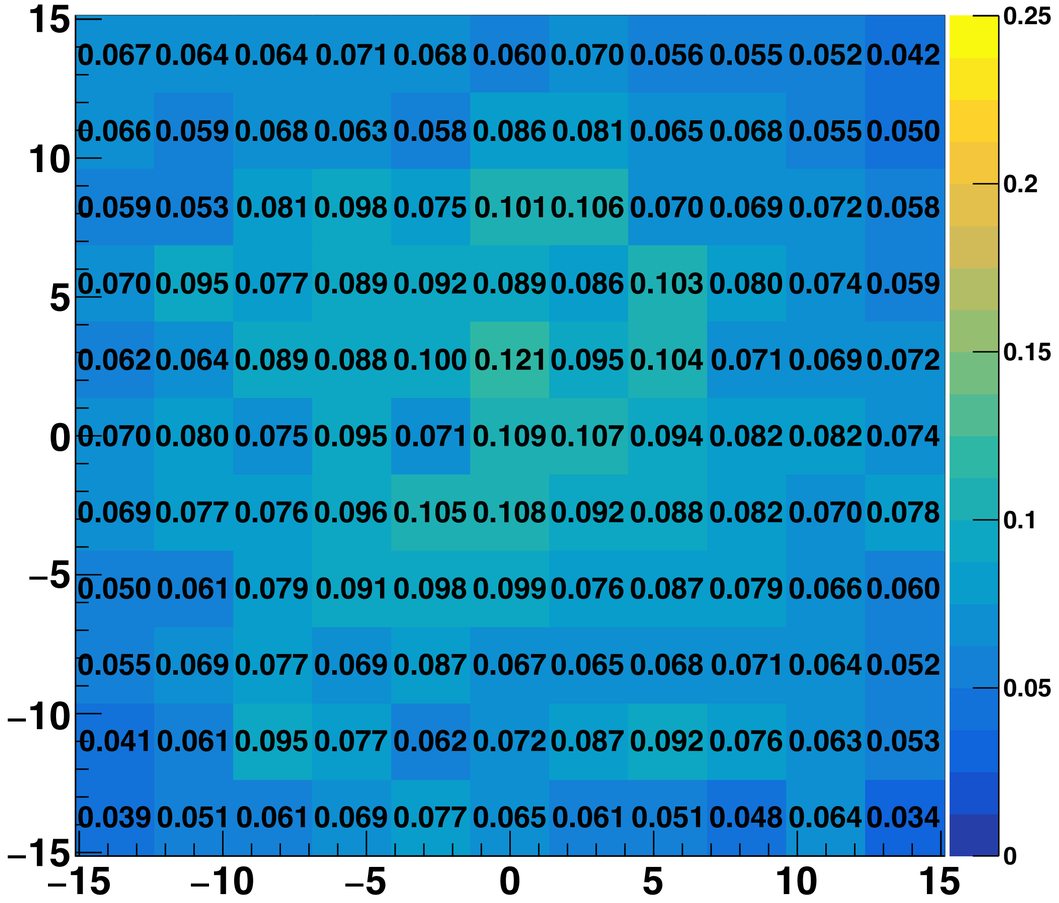


geometry 1.2 PMMA



statistic 11.000 - muon 1 GeV

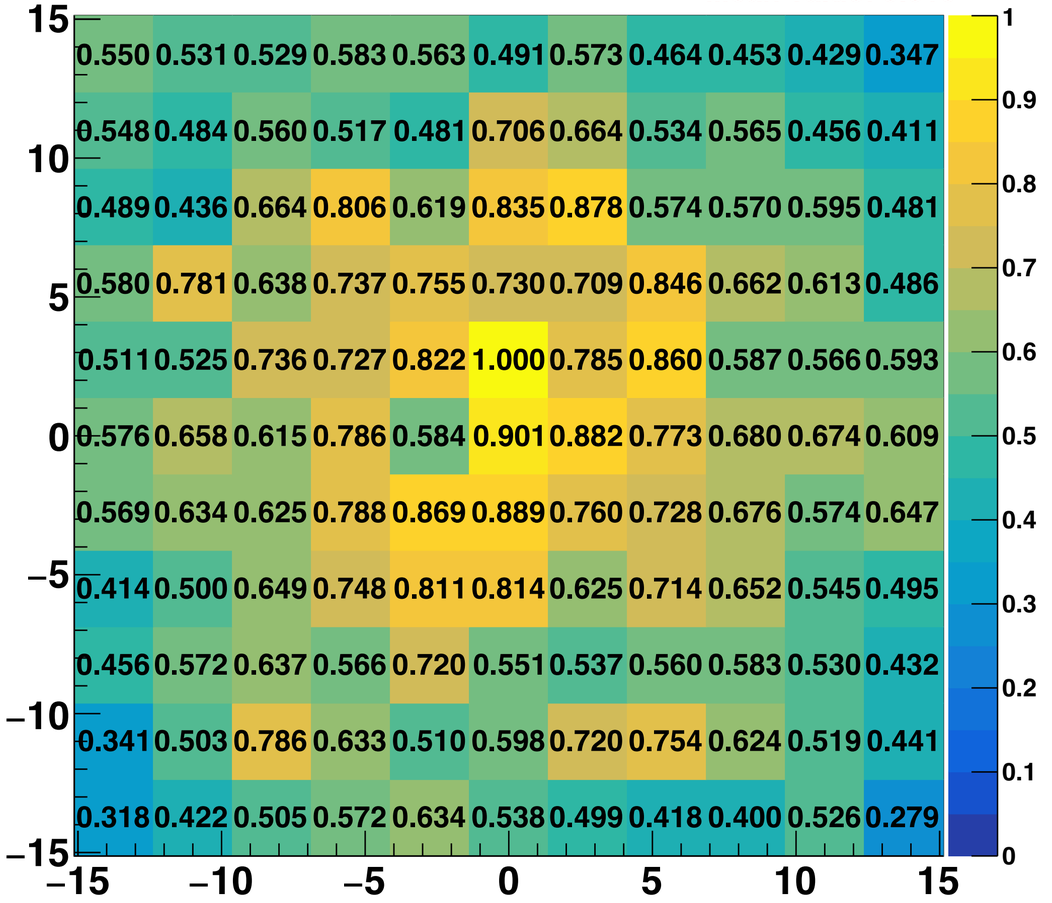
Efficiency - LG - PMMA - 4cm - base 8.9 mm



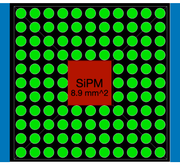
Factor non-uniformity - LG - PMMA - 4cm - base 8.9 mm

Standard deviation: 0.138

Mean value: 0.610

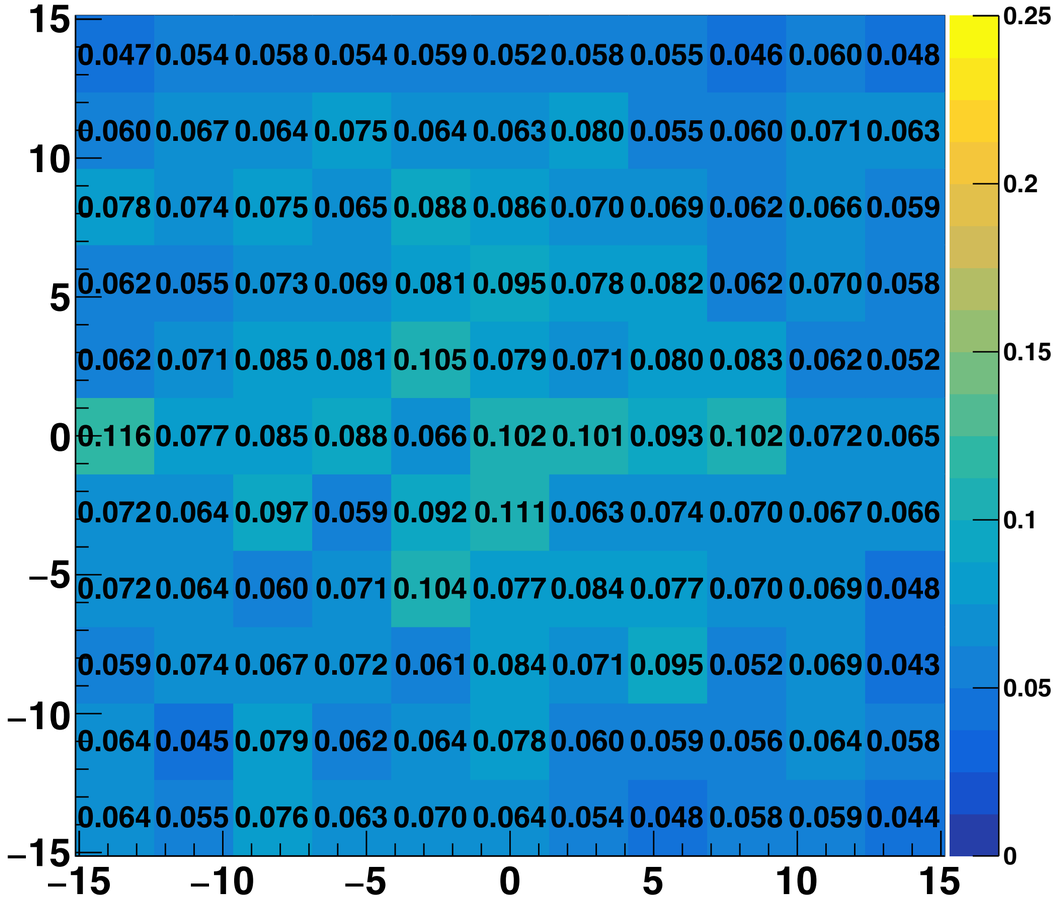


geometry 1.2 PMMA



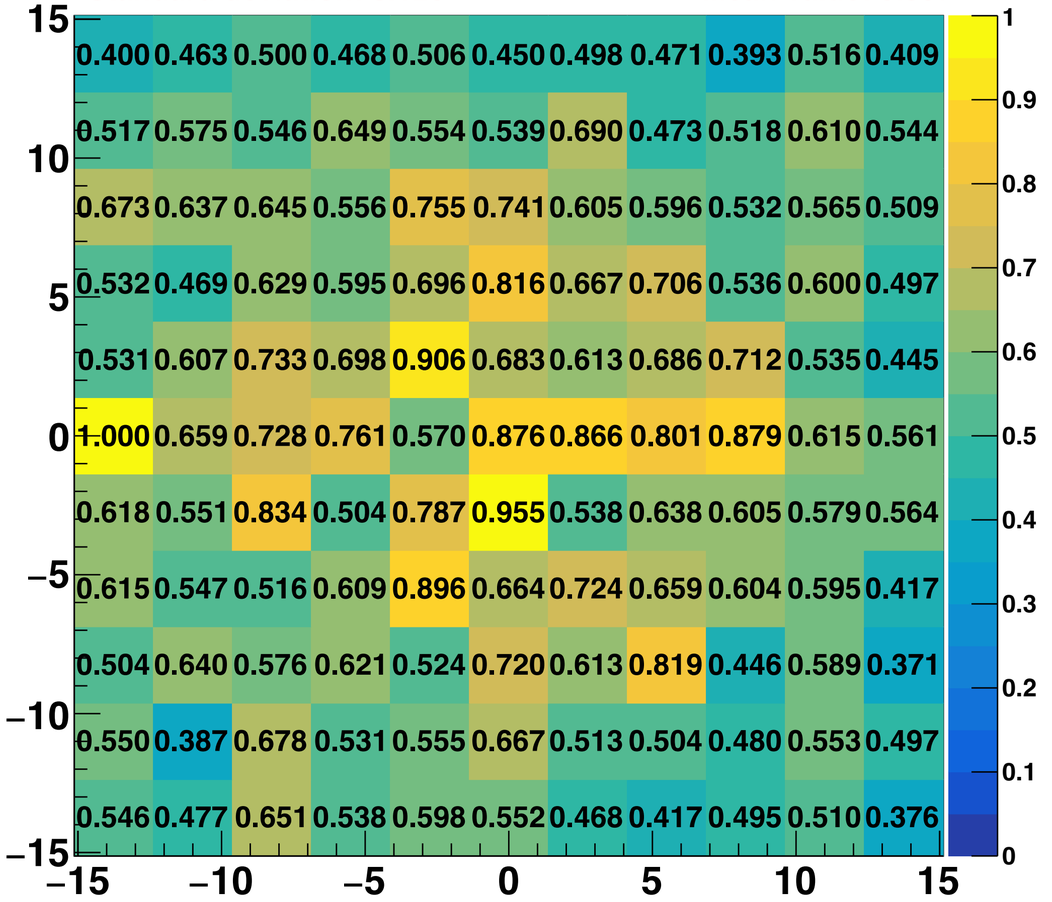
statistic 11.000 - muon 1 GeV

Efficiency - LG - PMMA - 5cm - base 8.9 mm

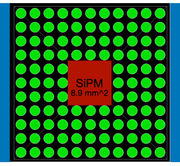


Factor non-uniformity - LG - PMMA - 5cm - base 8.9 mm

Standard deviation: 0.126 **Mean value: 0.597**

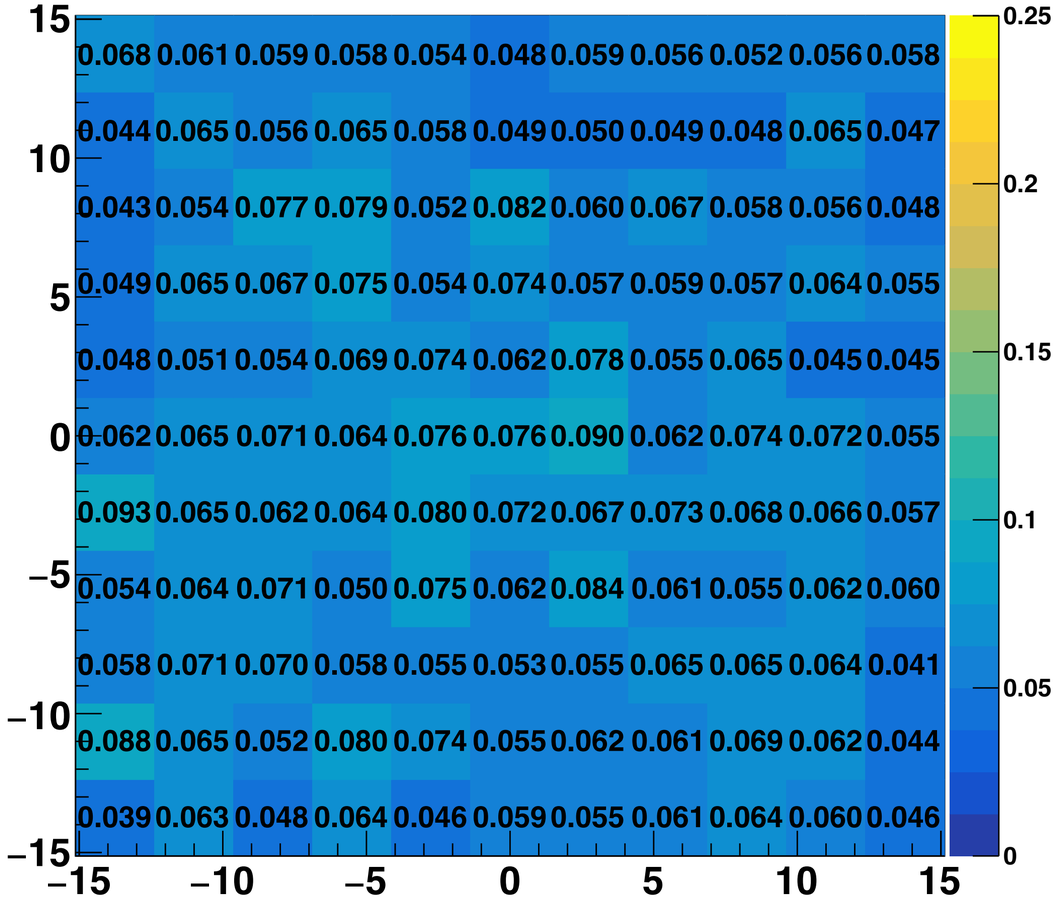


geometry 1.2 PMMA



statistic 11.000 - muon 1 GeV

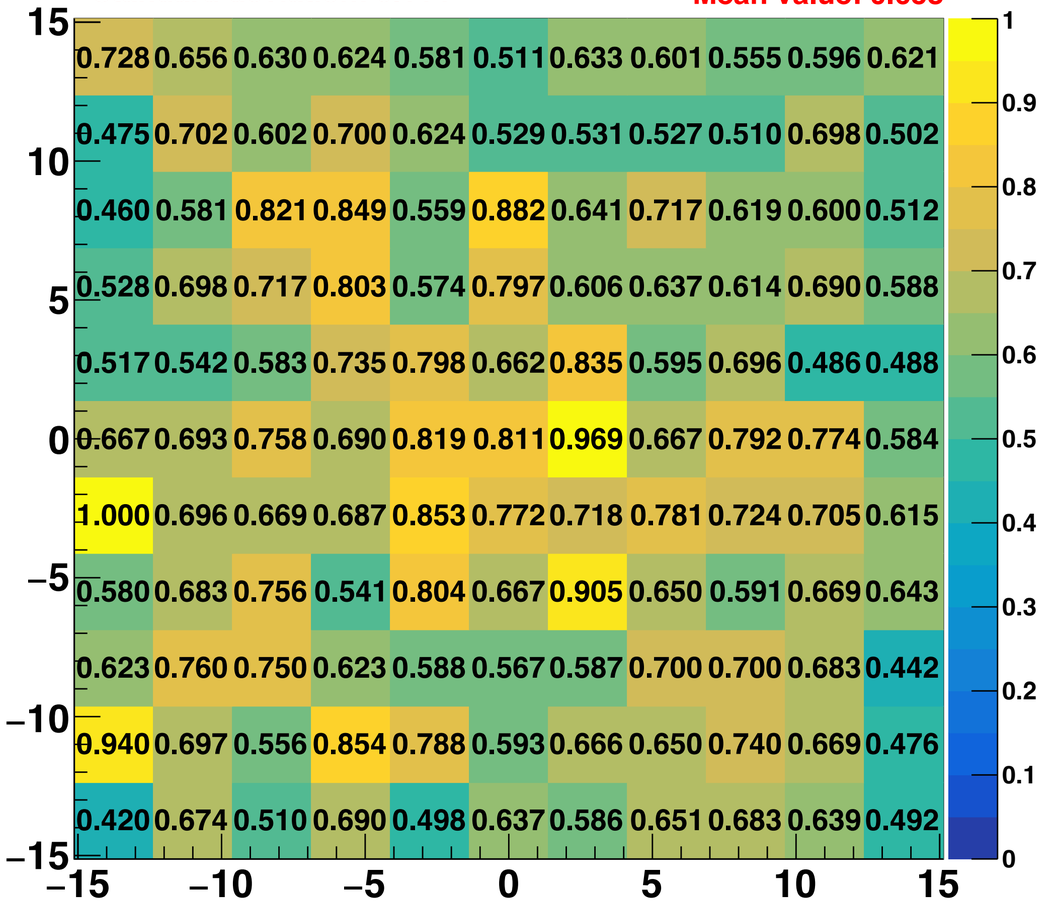
Efficiency - LG - PMMA - 6cm - base 8.9 mm



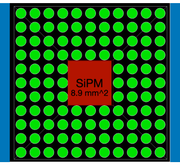
Factor non-uniformity - LG - PMMA - 6cm - base 8.9 mm

Standard deviation: 0.114

Mean value: 0.658

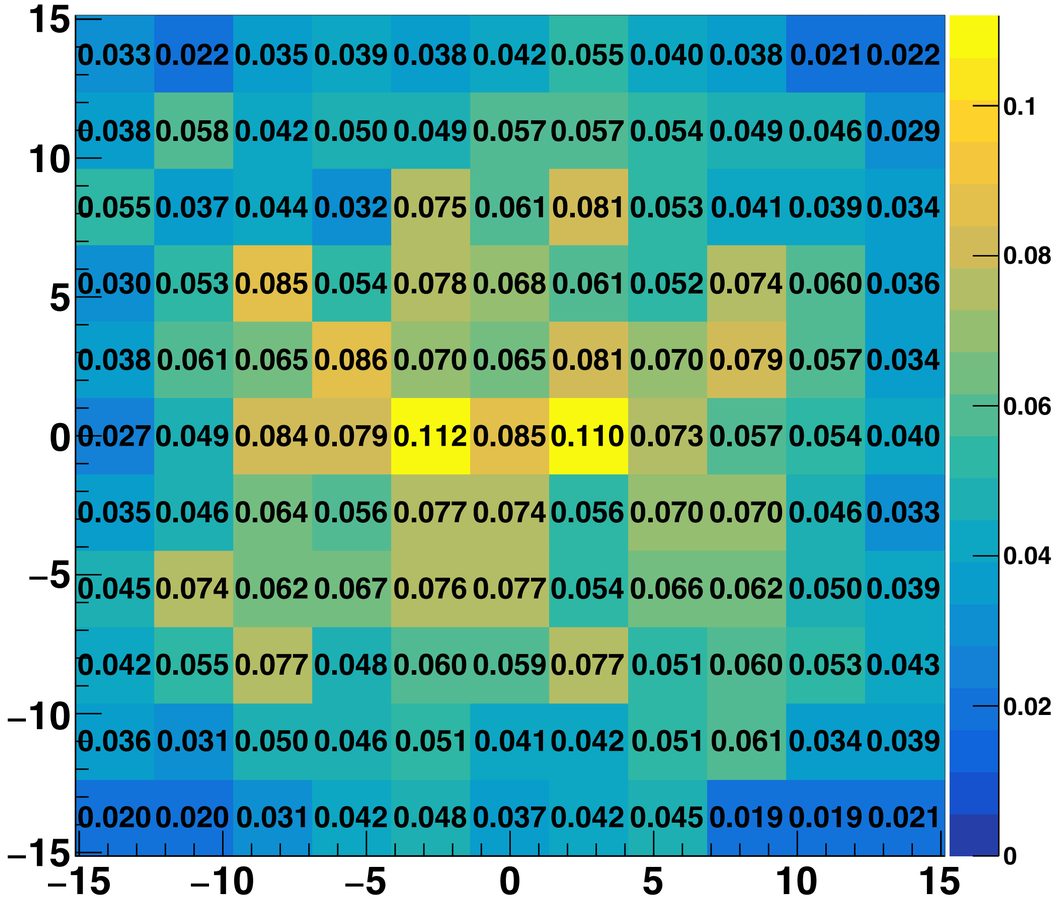


geometry 1.2 AIR



statistic 11.000 - muon 1 GeV

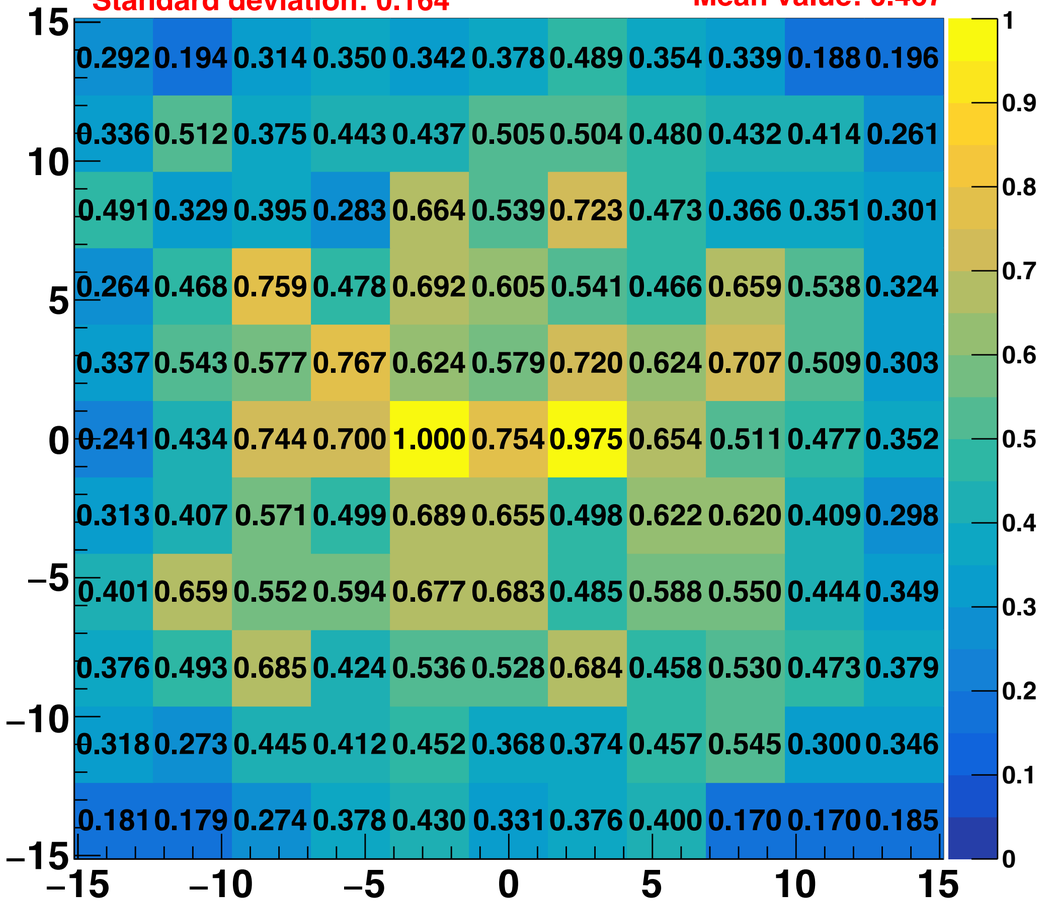
Efficiency - LG - Air - 2cm - base 8.9 mm



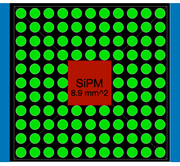
Factor non-uniformity - LG - AIR - 2cm - base 8.9 mm

Standard deviation: 0.164

Mean value: 0.467

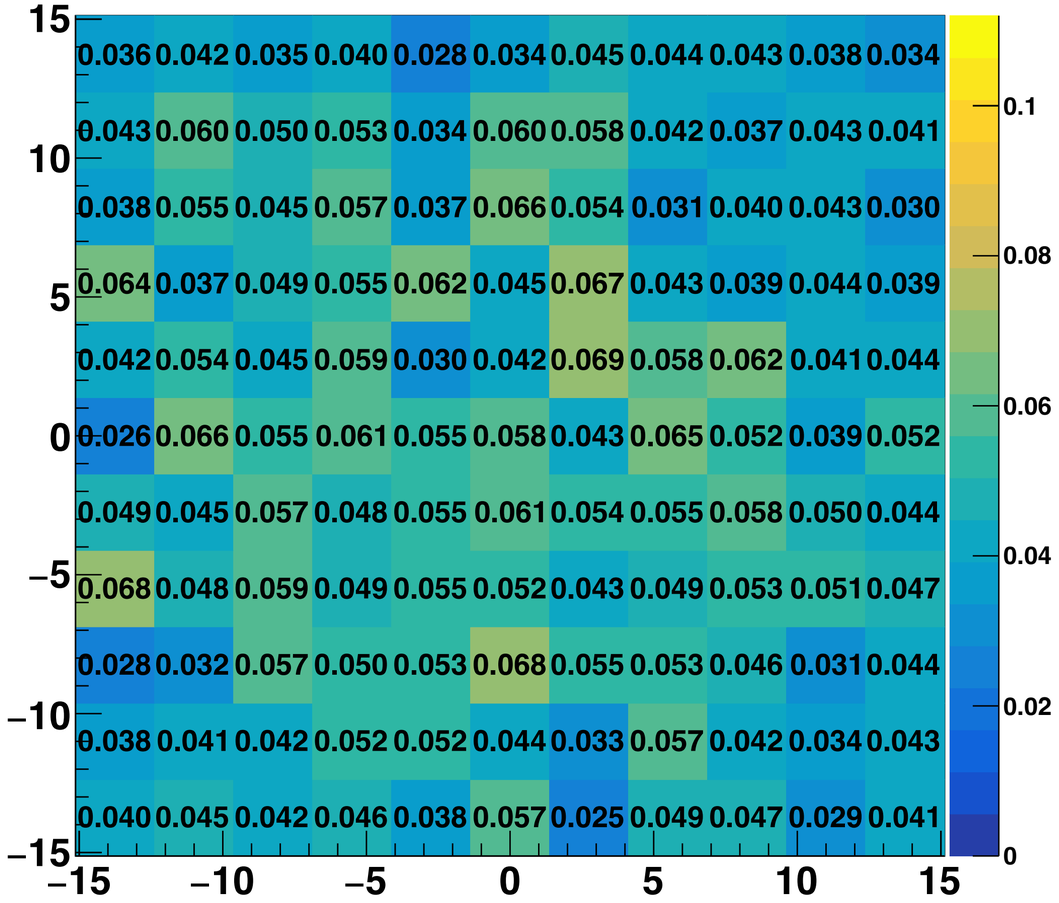


geometry 1.2 AIR



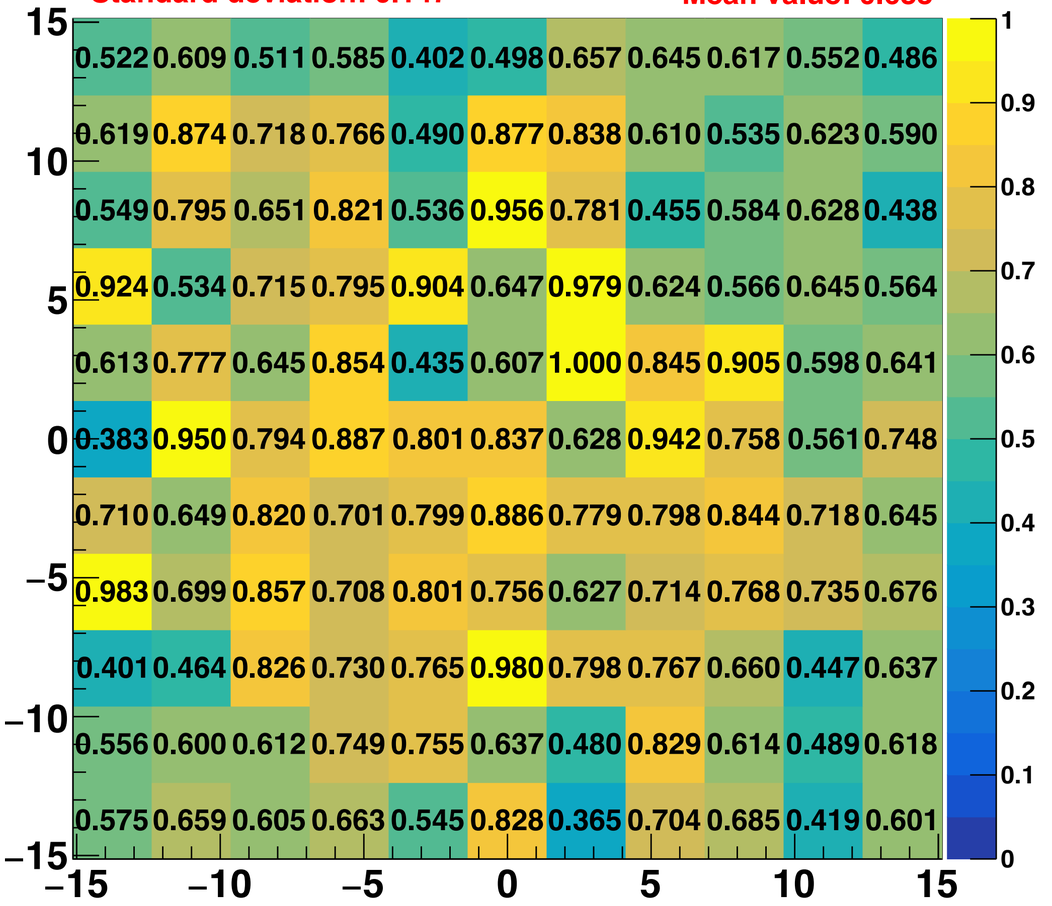
statistic 11.000 - muon 1 GeV

Efficiency - LG - Air - 3cm - base 8.9 mm

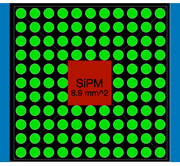


Factor non-uniformity - LG - AIR - 3cm - base 8.9 mm

Standard deviation: 0.147 **Mean value: 0.683**

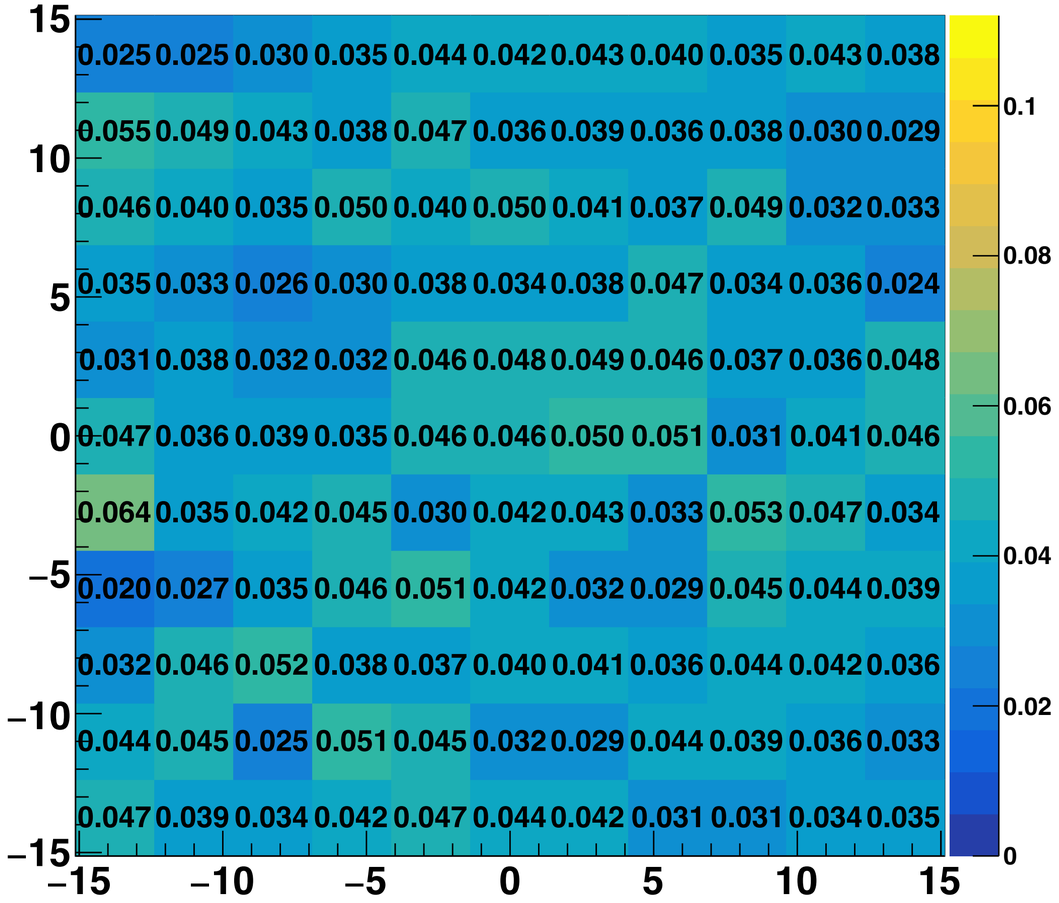


geometry 1.2 AIR



statistic 11.000 - muon 1 GeV

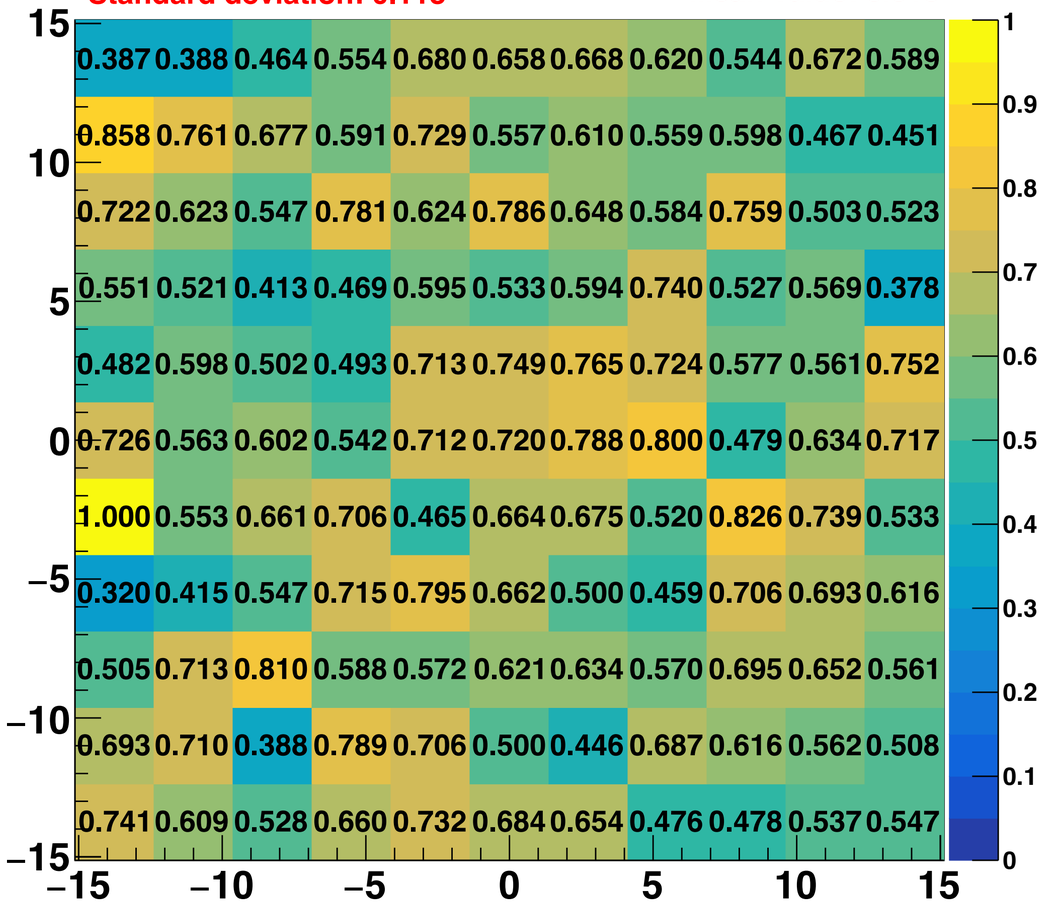
Efficiency - LG - Air - 4cm - base 8.9 mm



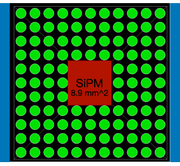
Factor non-uniformity - LG - AIR - 4cm - base 8.9 mm

Standard deviation: 0.118

Mean value: 0.613

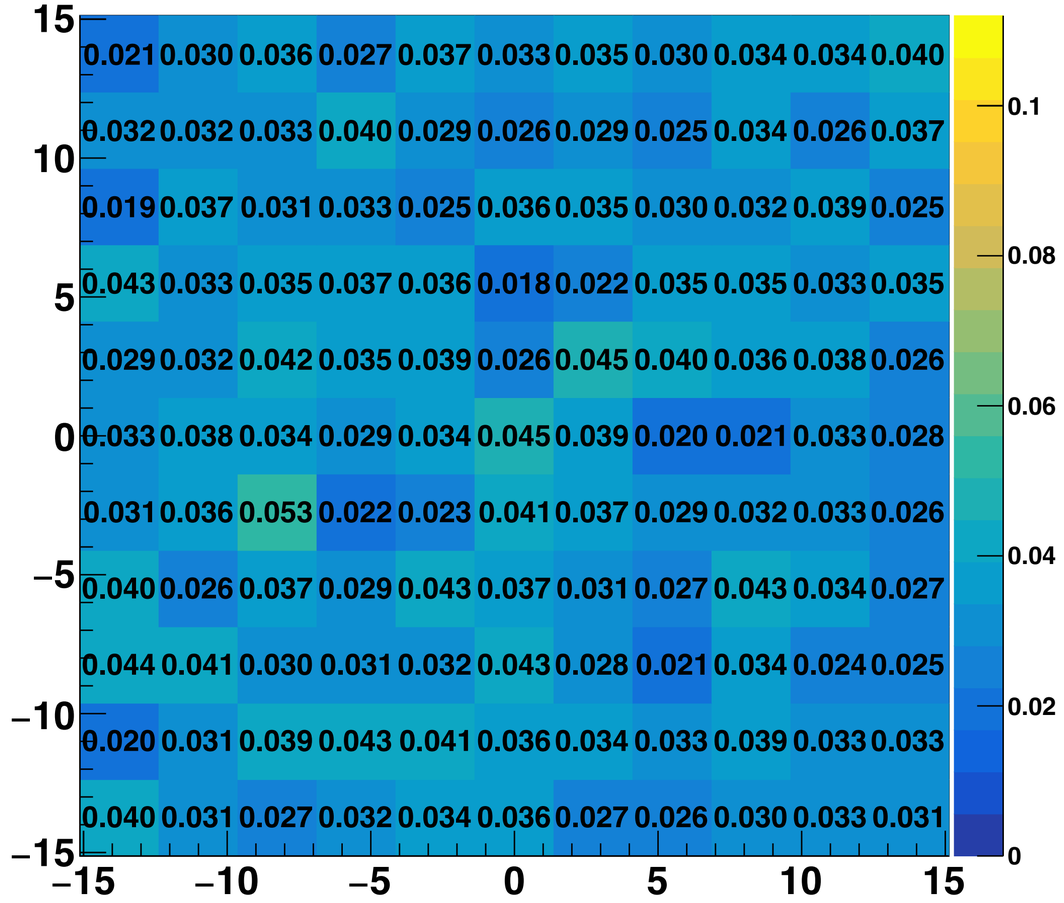


geometry 1.2 AIR



statistic 11.000 - muon 1 GeV

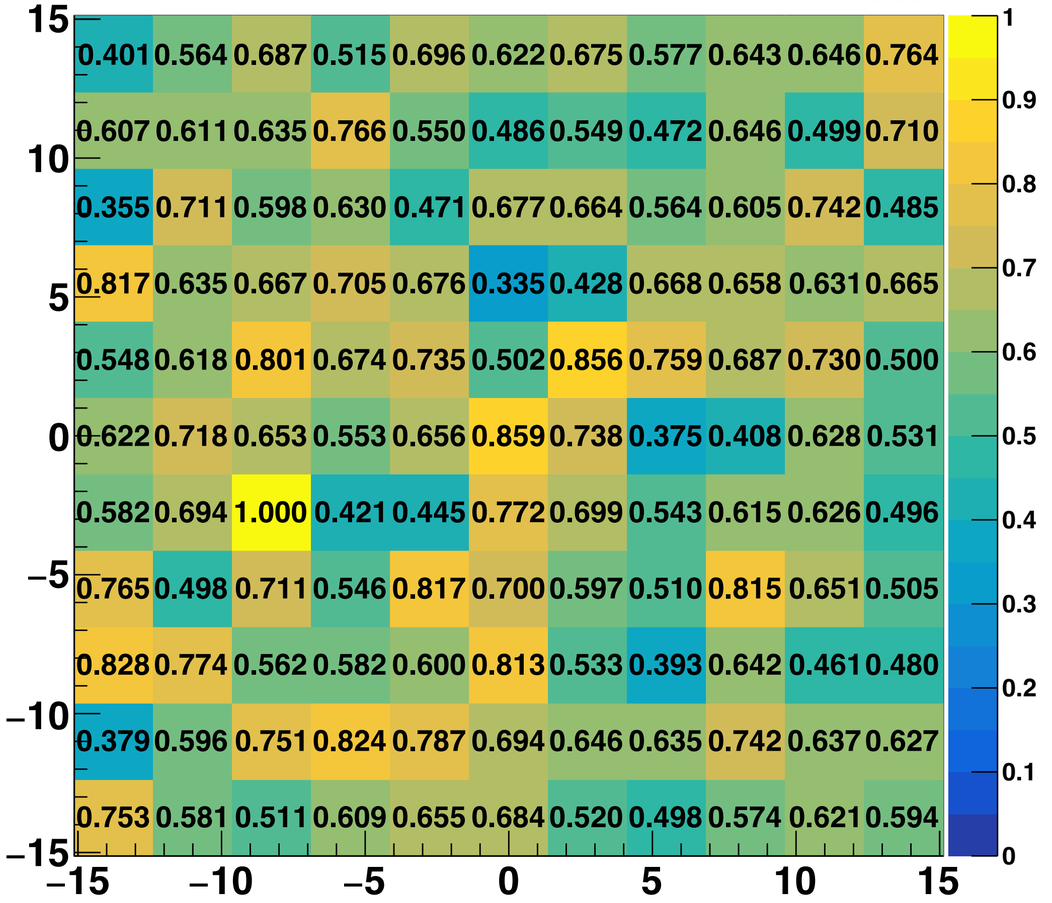
Efficiency - LG - Air - 5cm - base 8.9 mm



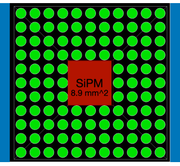
Factor non-uniformity - LG - AIR - 5cm - base 8.9 mm

Standard deviation: 0.121

Mean value: 0.624

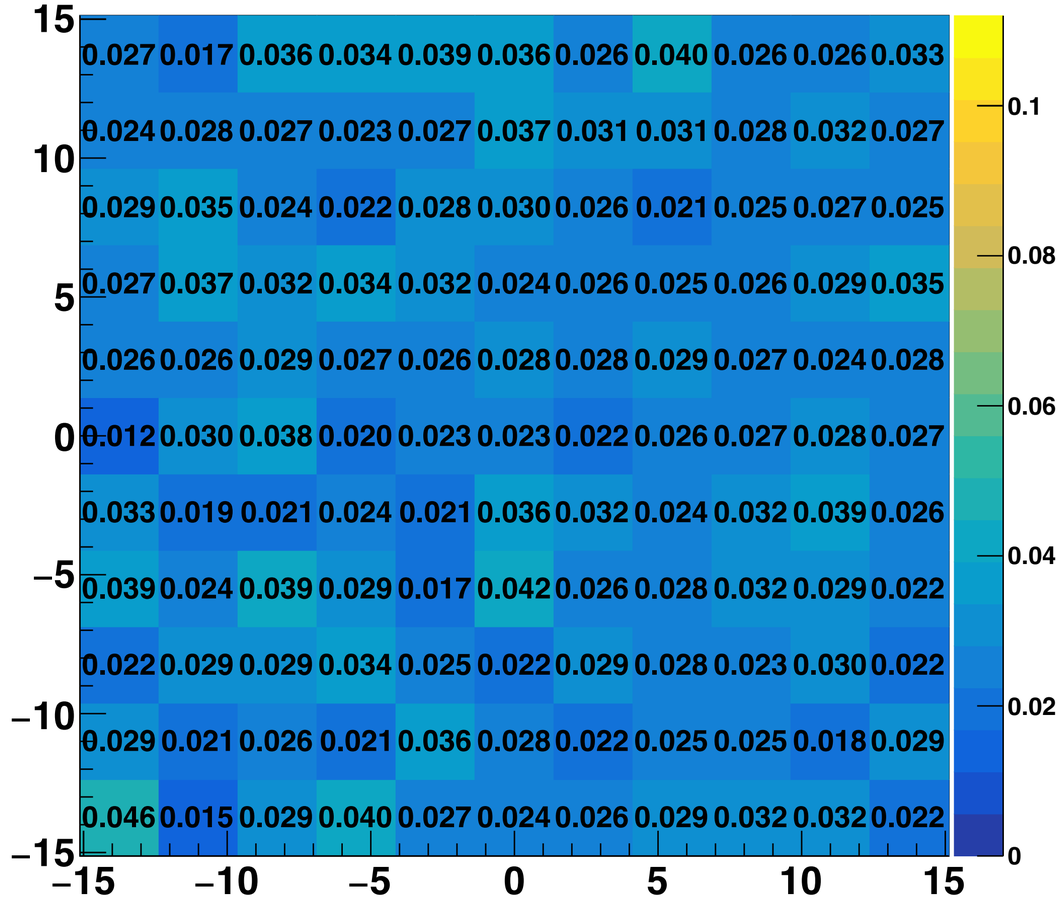


geometry 1.2 AIR



statistic 11.000 - muon 1 GeV

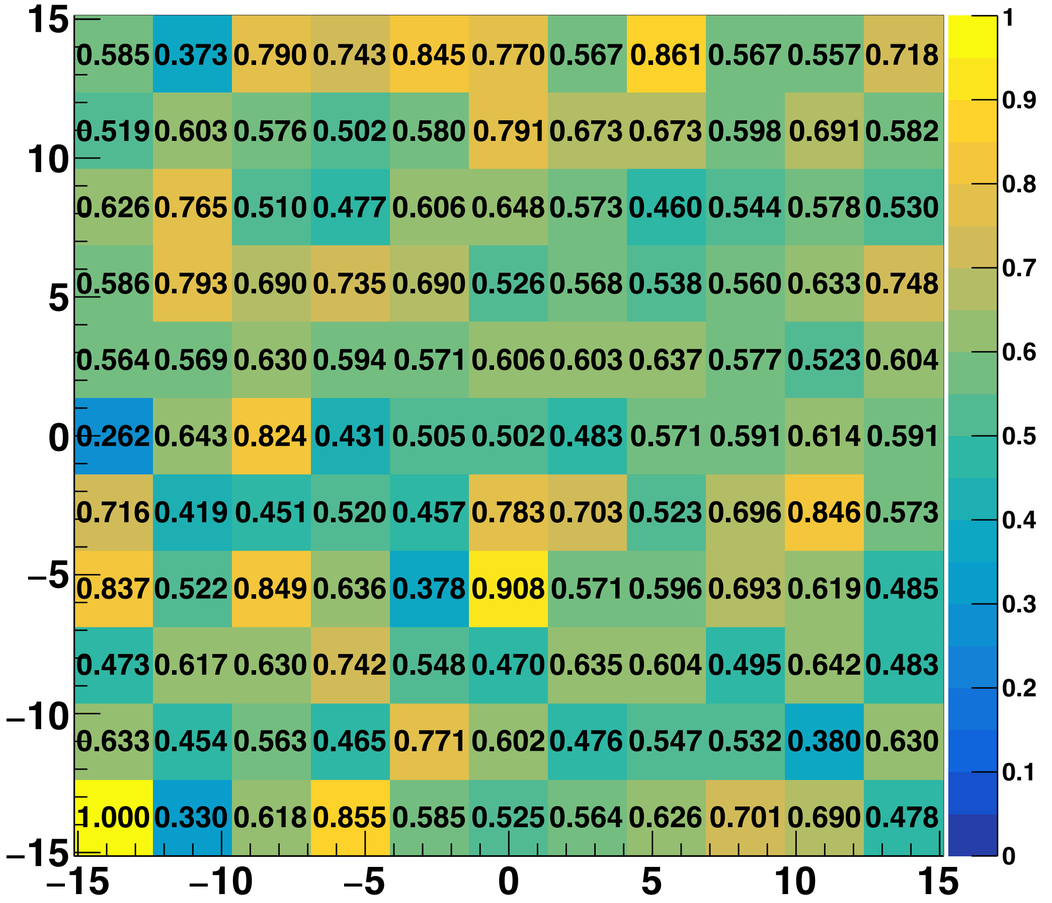
Efficiency - LG - Air - 6cm - base 8.9 mm

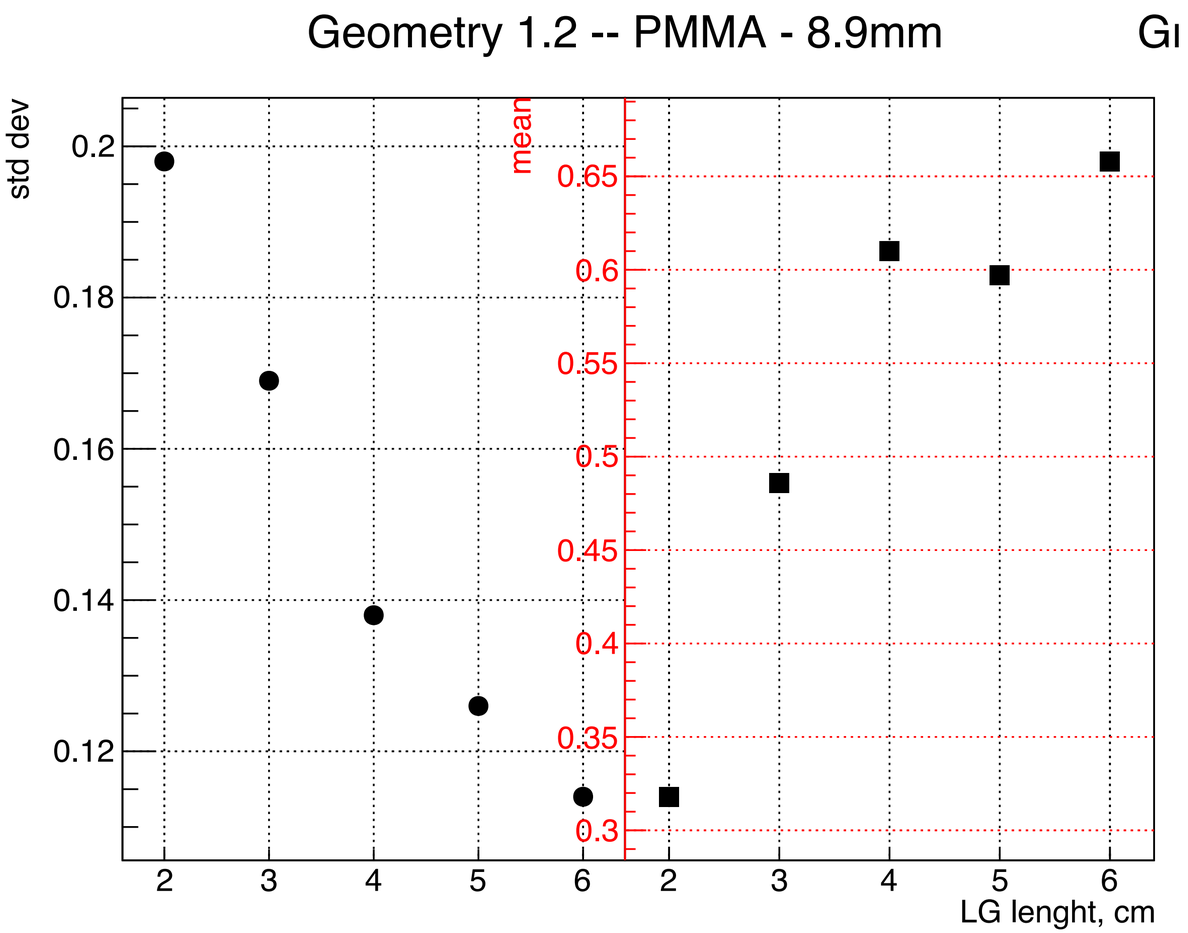


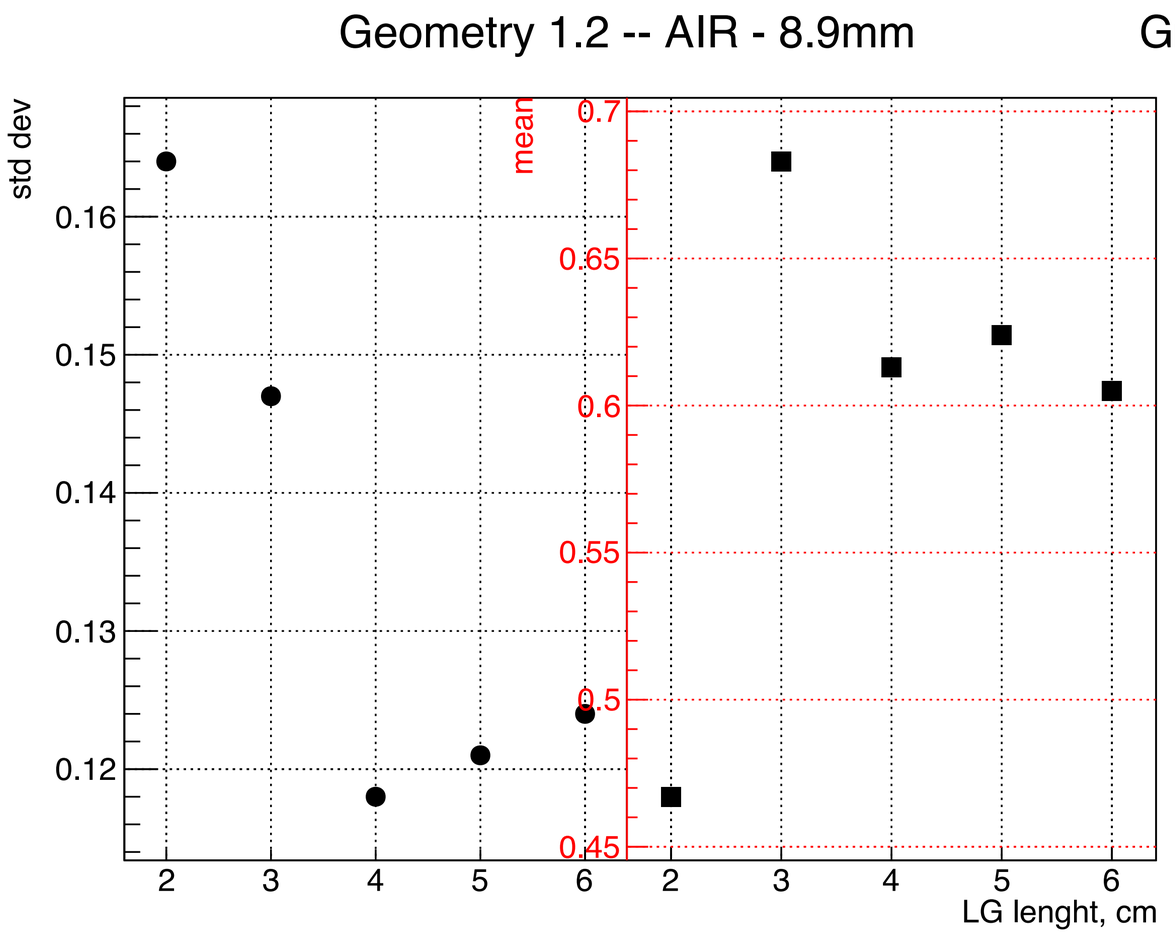
Factor non-uniformity - LG - AIR - 6cm - base 8.9 mm

Standard deviation: 0.124

Mean value: 0.605



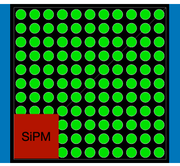

Geometry 1.2 -- PMMA - 8.9mm
Gı
std dev
mean
0.2
0.18
0.16
0.14
0.12
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
2
3
4
5
6
LG lenght, cm


Geometry 1.2 -- AIR - 8.9mm
Graph
std dev
mean
0.16
0.15
0.14
0.13
0.12
0.7
0.65
0.6
0.55
0.5
0.45
2
3
4
5
6
LG lenght, cm

geometry 3

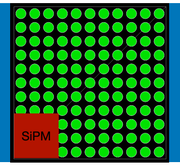
PMMA

Air



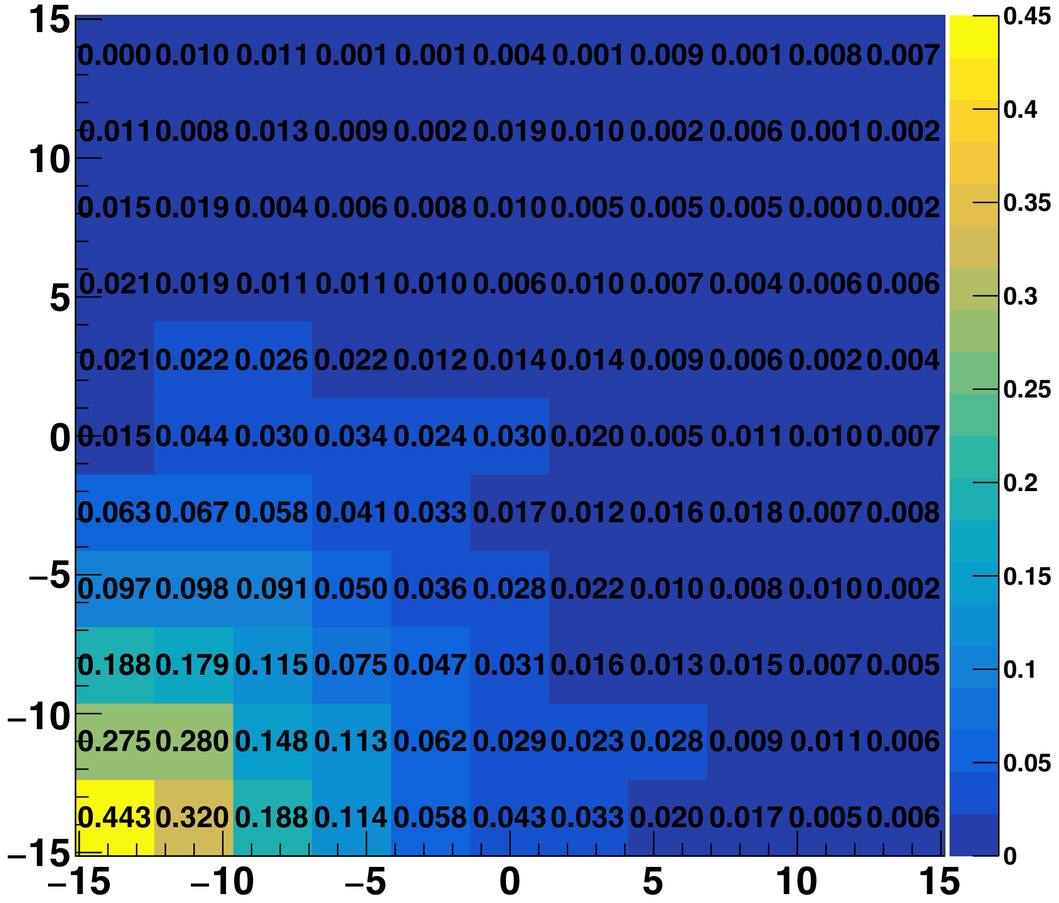
statistic 11.000 - muon 1 GeV

geometry 3 PMMA



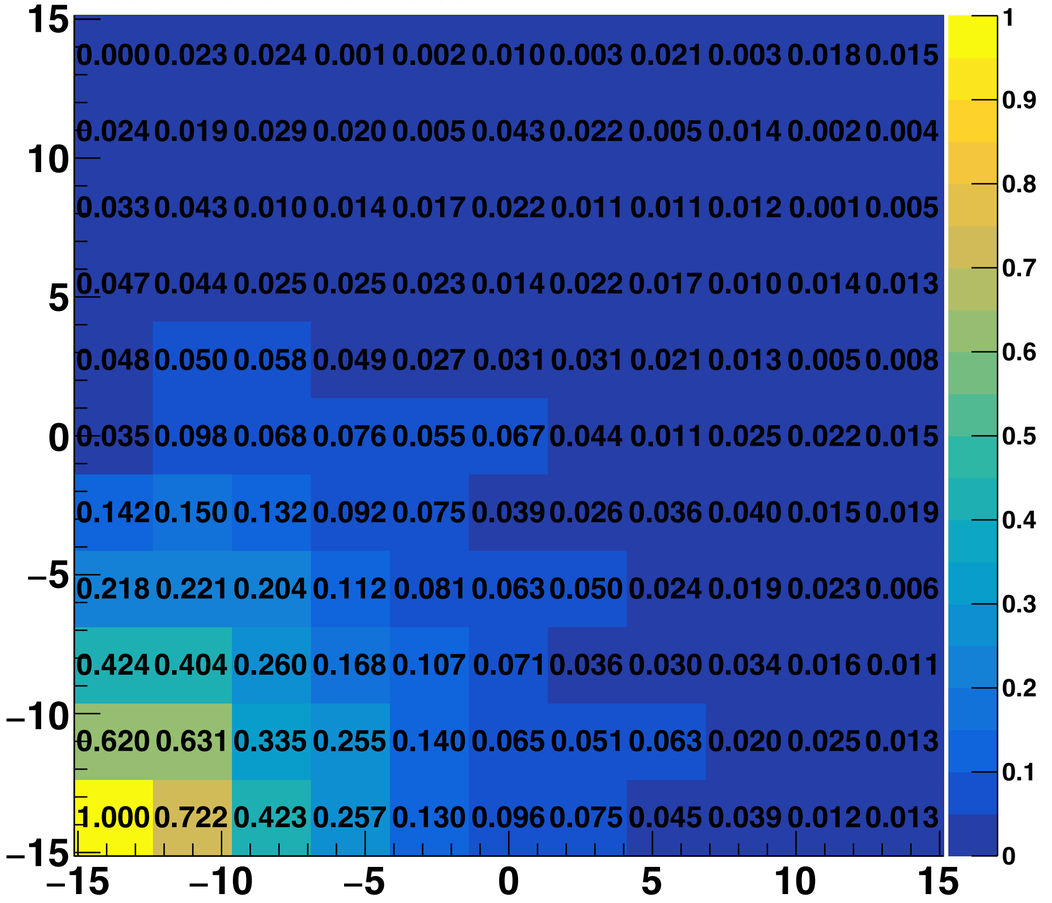
statistic 11.000 - muon 1 GeV

Efficiency - LG - PMMA - 2cm - base 8.9 mm

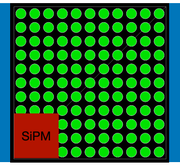


Factor non-uniformity - LG - PMMA - 2cm - base 8.9 mm

Standard deviation: 0.150 **Mean value: 0.082**

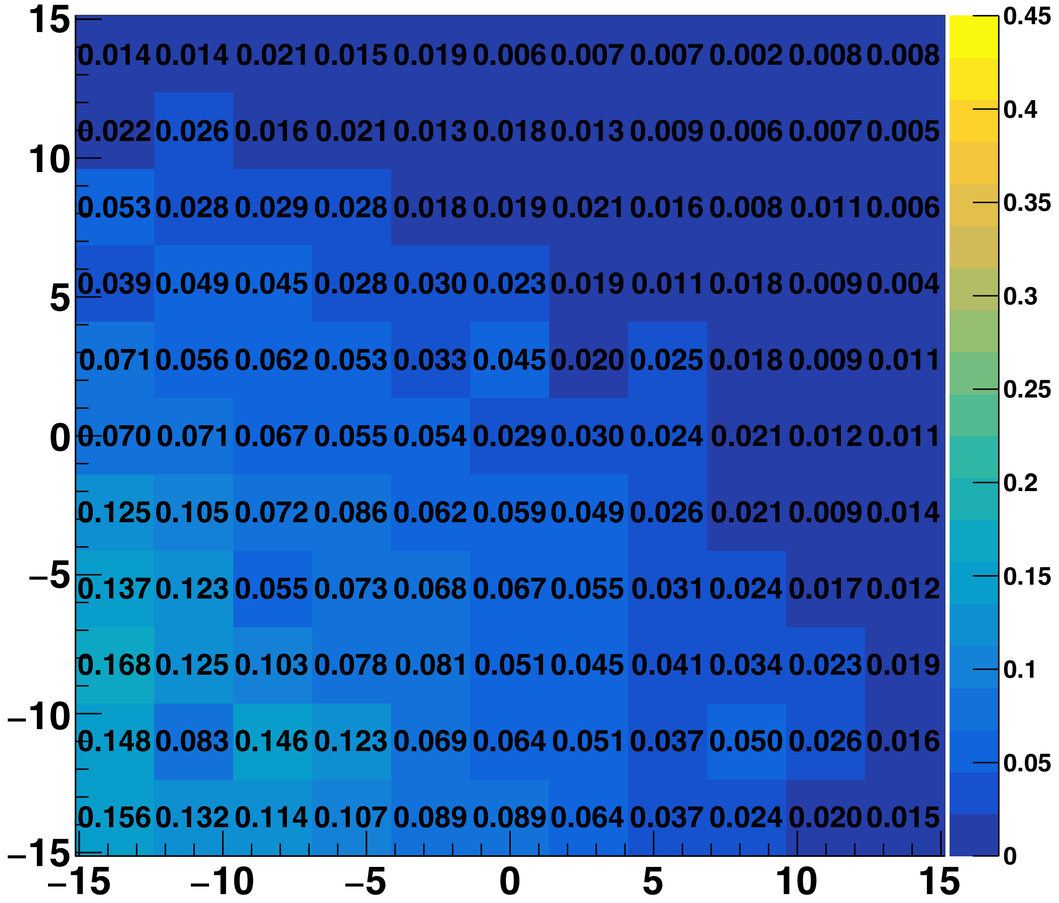


geometry 3 PMMA



statistic 11.000 - muon 1 GeV

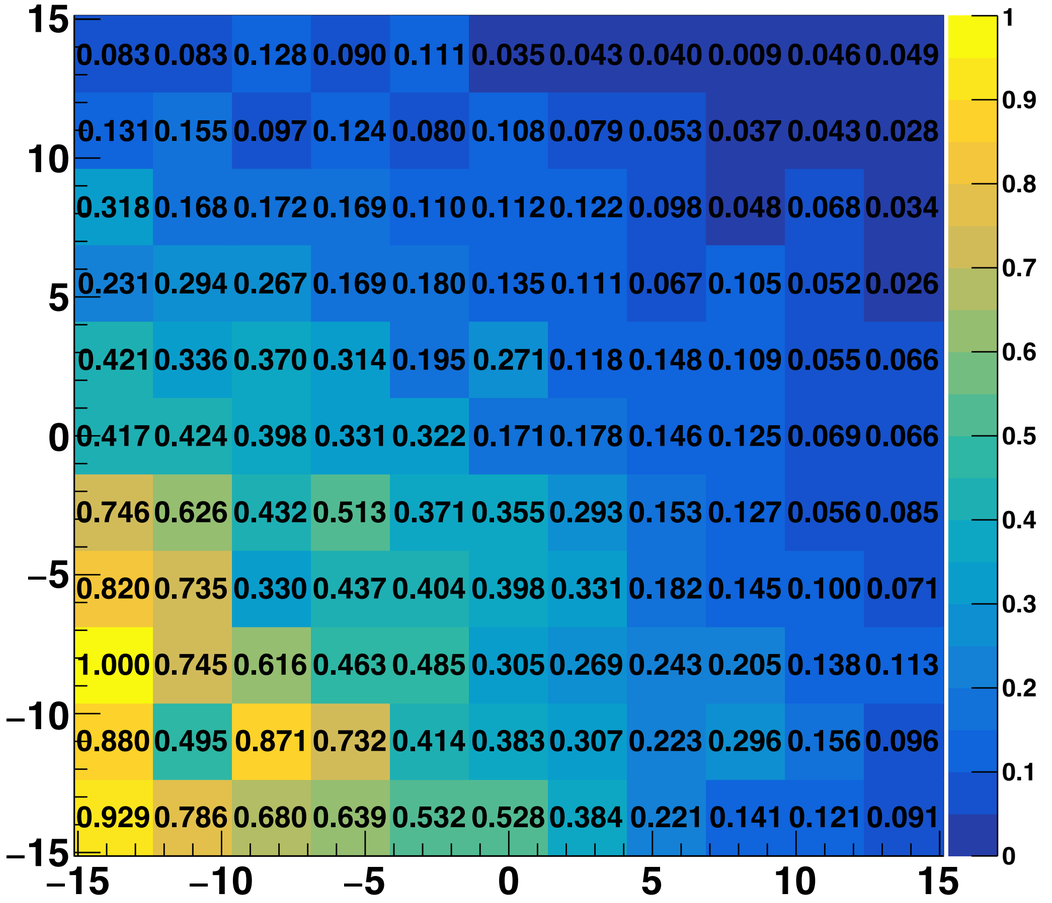
Efficiency - LG - PMMA - 3cm - base 8.9 mm



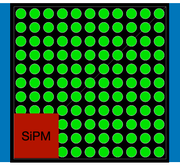
Factor non-uniformity - LG - PMMA - 3cm - base 8.9 mm

Standard deviation: 0.229

Mean value: 0.264

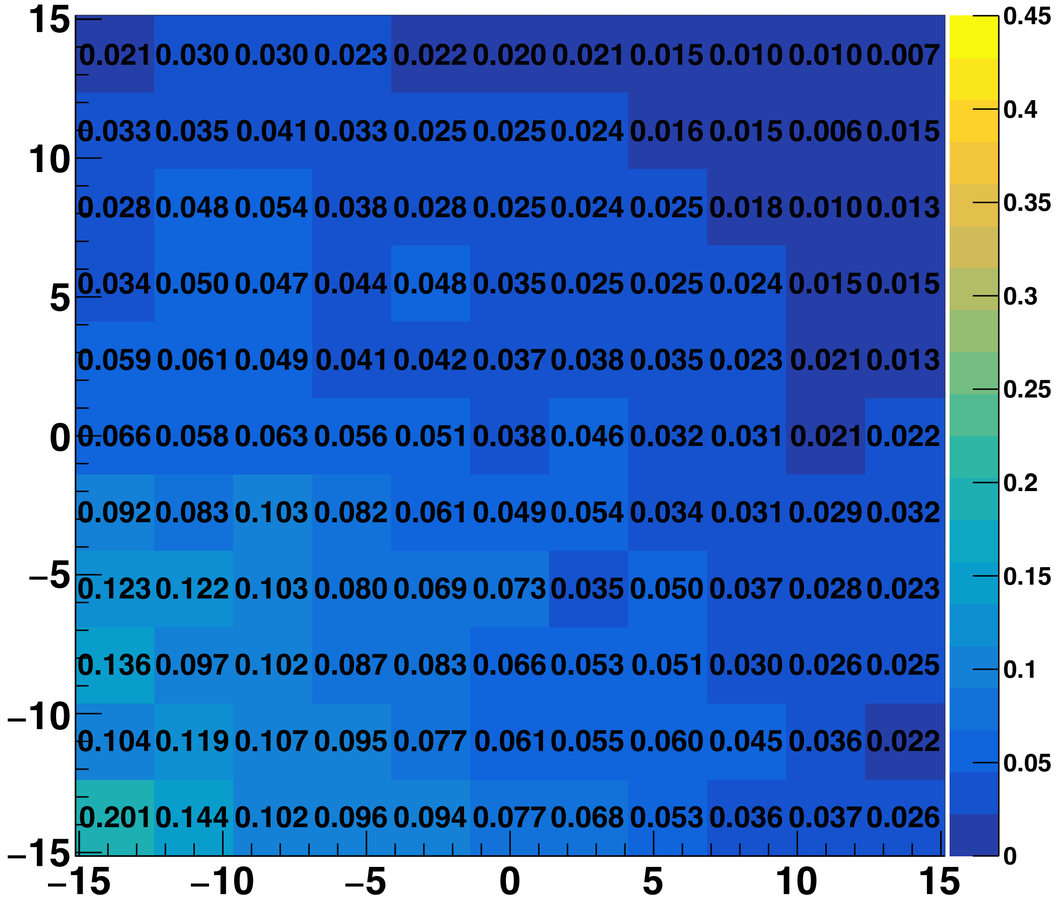


geometry 3 PMMA



statistic 11.000 - muon 1 GeV

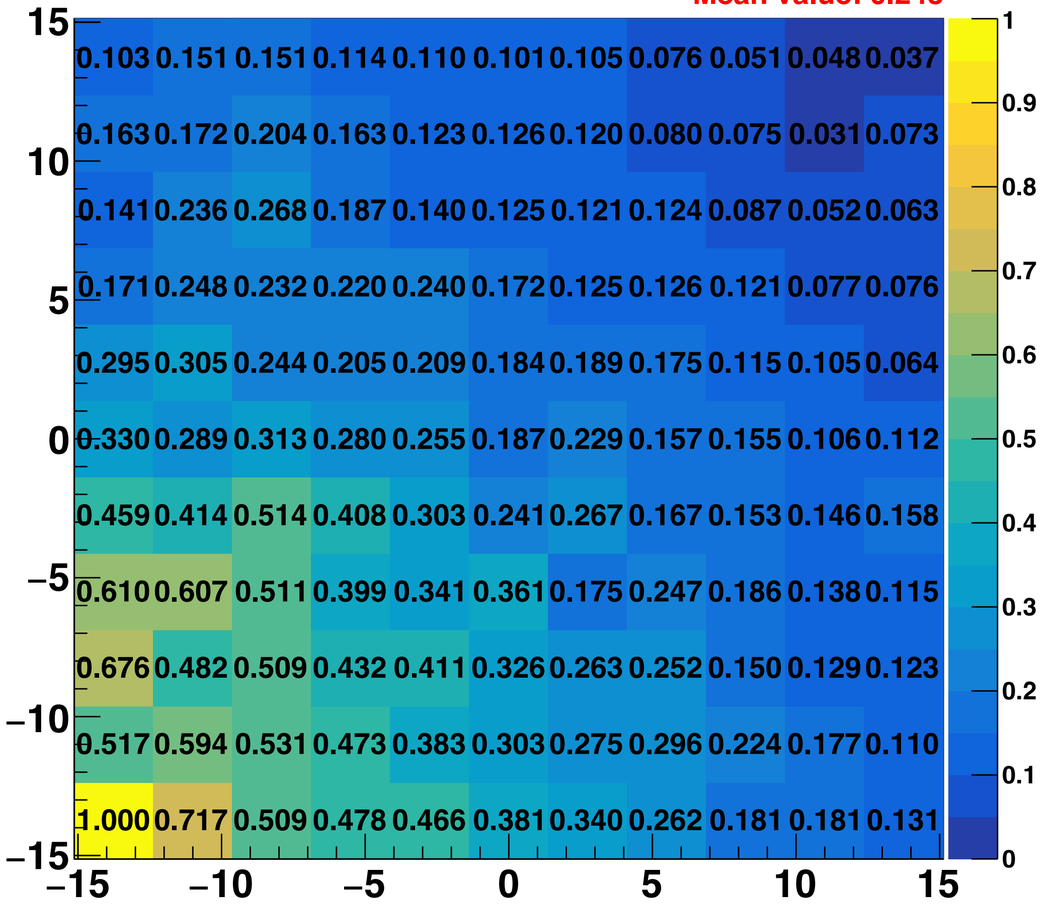
Efficiency - LG - PMMA - 4cm - base 8.9 mm



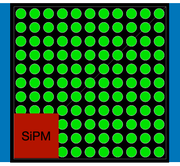
Factor non-uniformity - LG - PMMA - 4cm - base 8.9 mm

Standard deviation: 0.166

Mean value: 0.243

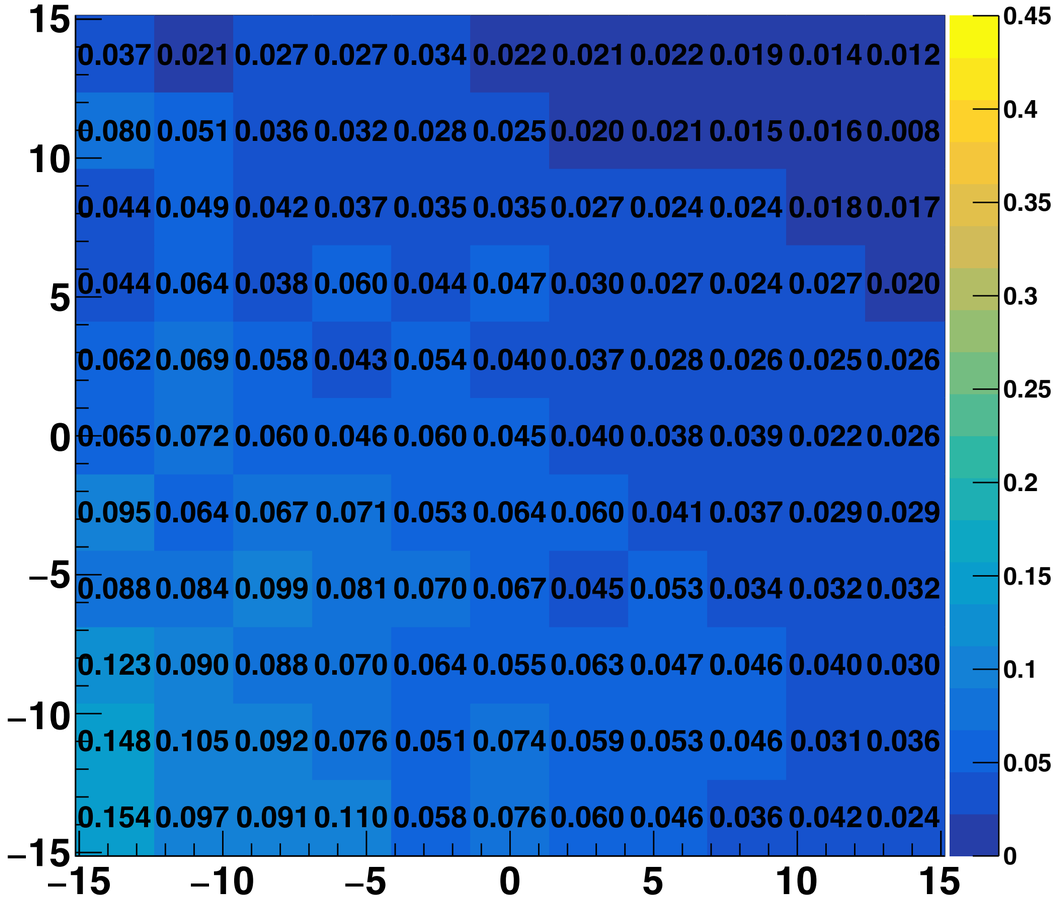


geometry 3 PMMA



statistic 11.000 - muon 1 GeV

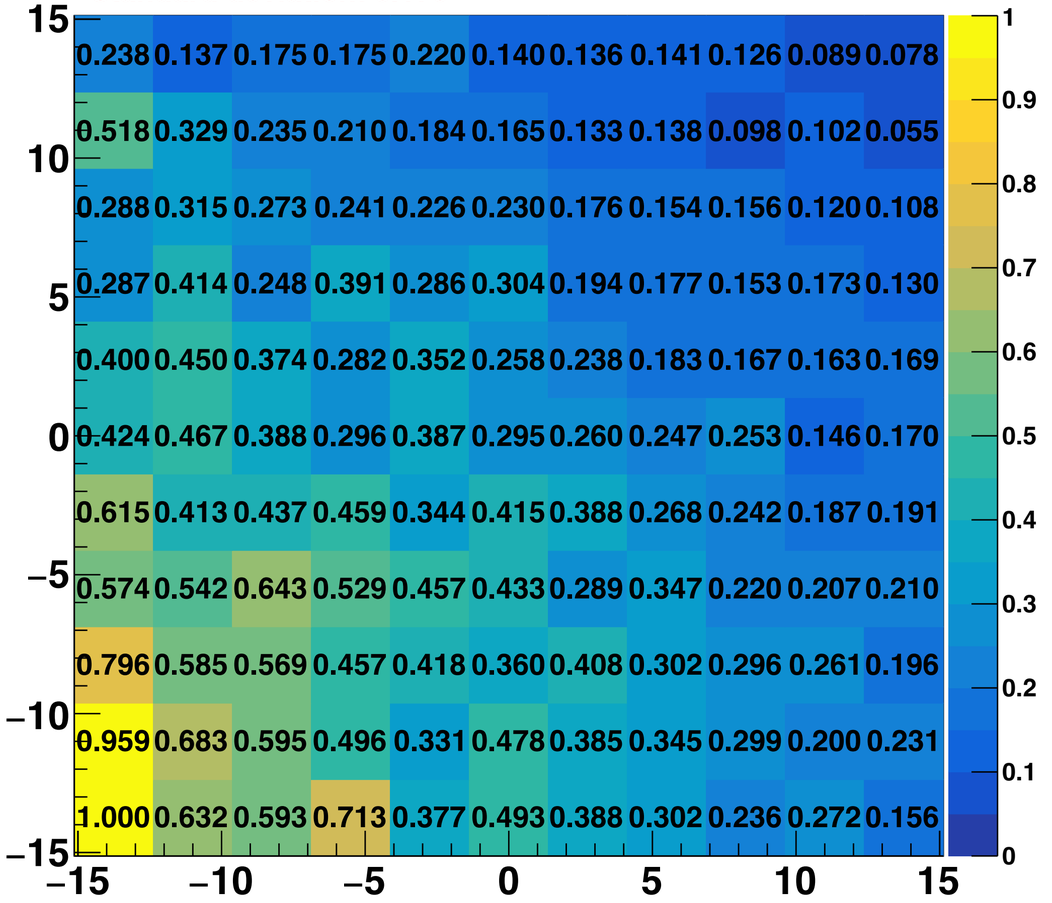
Efficiency - LG - PMMA - 5cm - base 8.9 mm



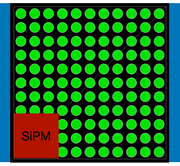
Factor non-uniformity - LG - PMMA - 5cm - base 8.9 mm

Standard deviation: 0.176

Mean value: 0.318

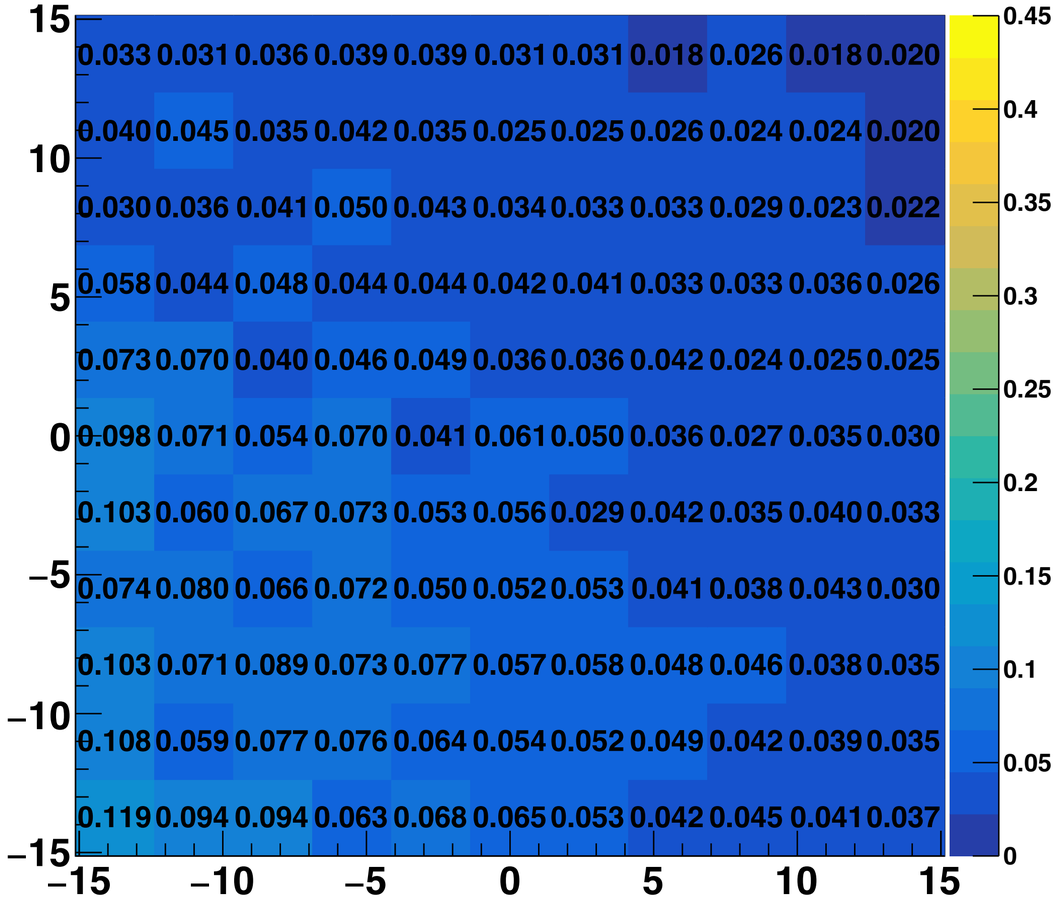


geometry 3 PMMA



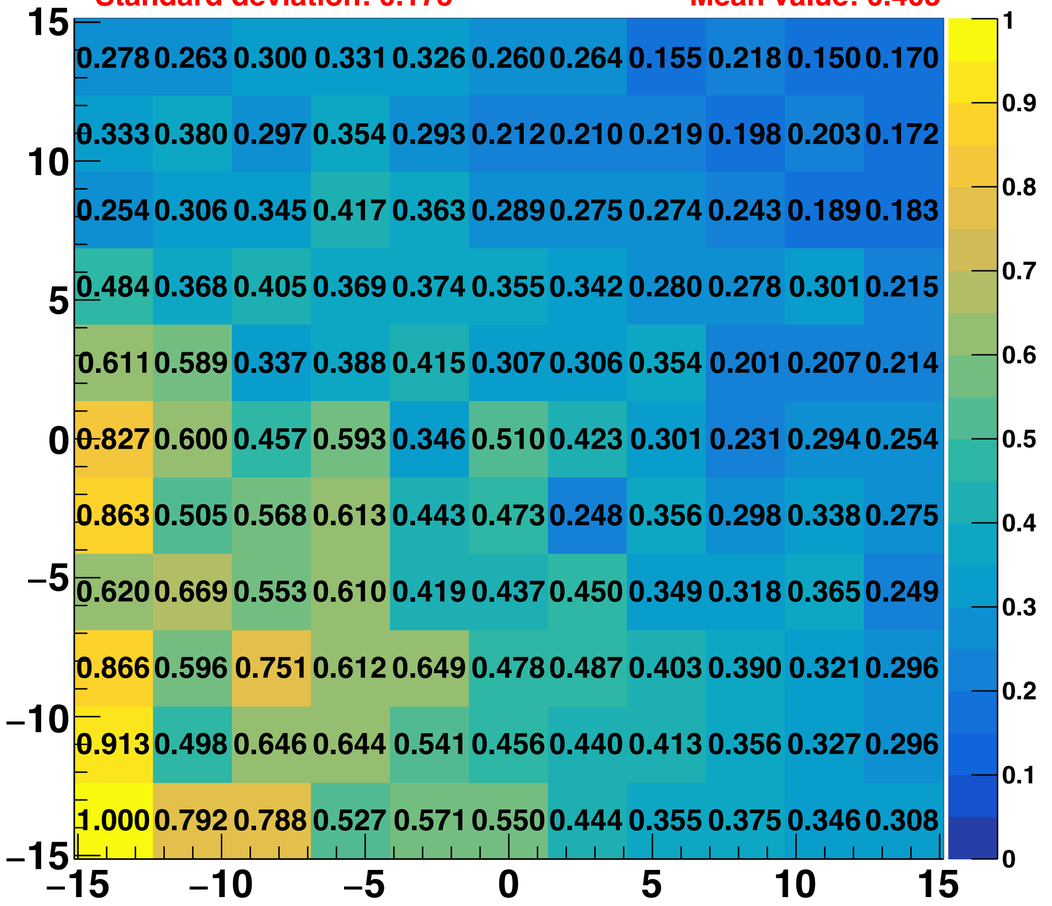
statistic 11.000 - muon 1 GeV

Efficiency - LG - PMMA - 6cm - base 8.9 mm

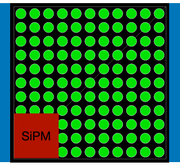


Factor non-uniformity - LG - PMMA - 6cm - base 8.9 mm

Standard deviation: 0.175 **Mean value: 0.403**

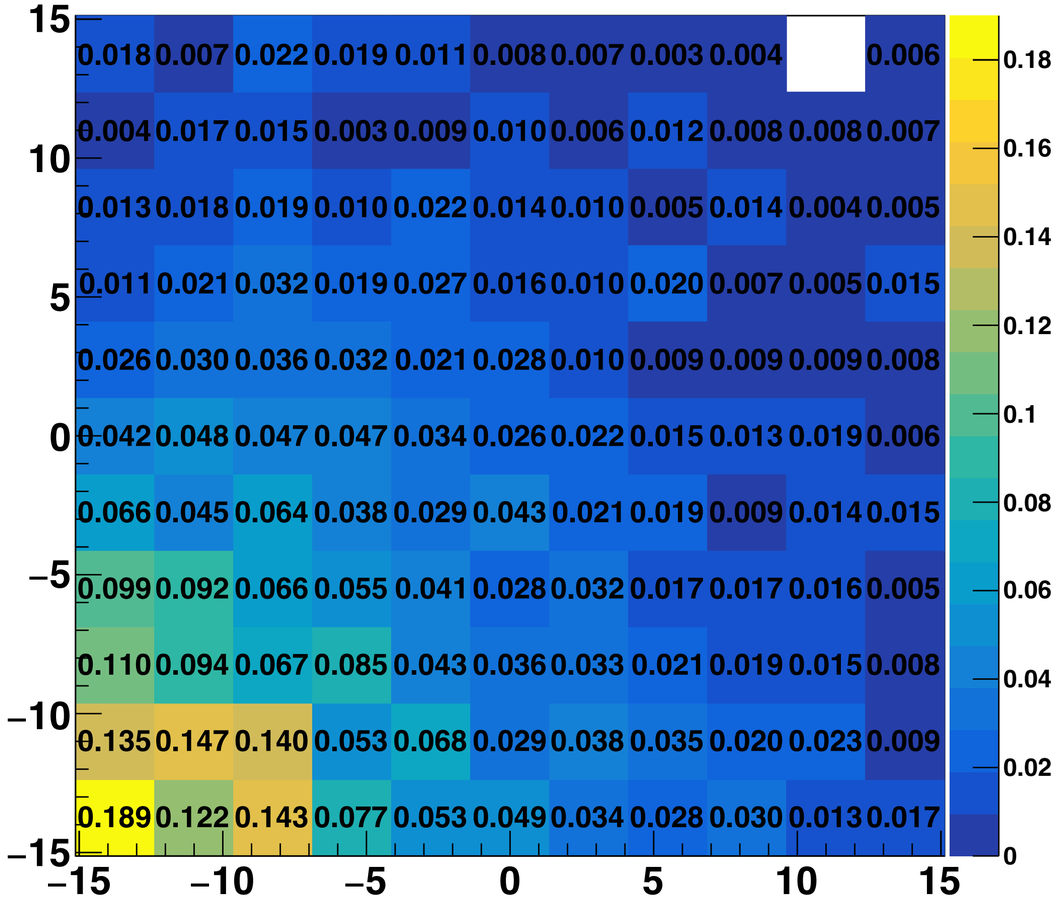


geometry 3 AIR



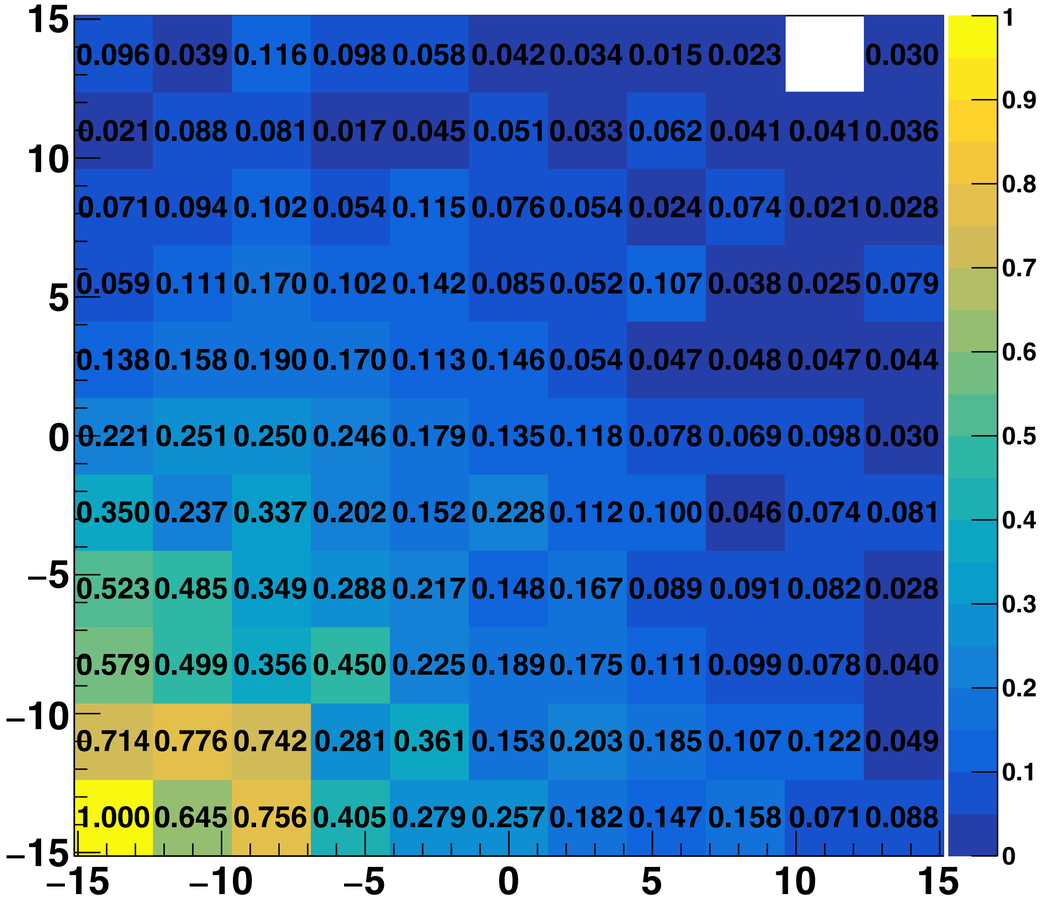
statistic 11.000 - muon 1 GeV

Efficiency - LG - Air - 2cm - base 8.9 mm

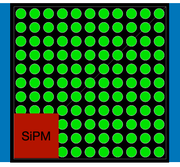


Factor non-uniformity - LG - AIR - 2cm - base 8.9 mm

Standard deviation: 0.181 **Mean value: 0.170**

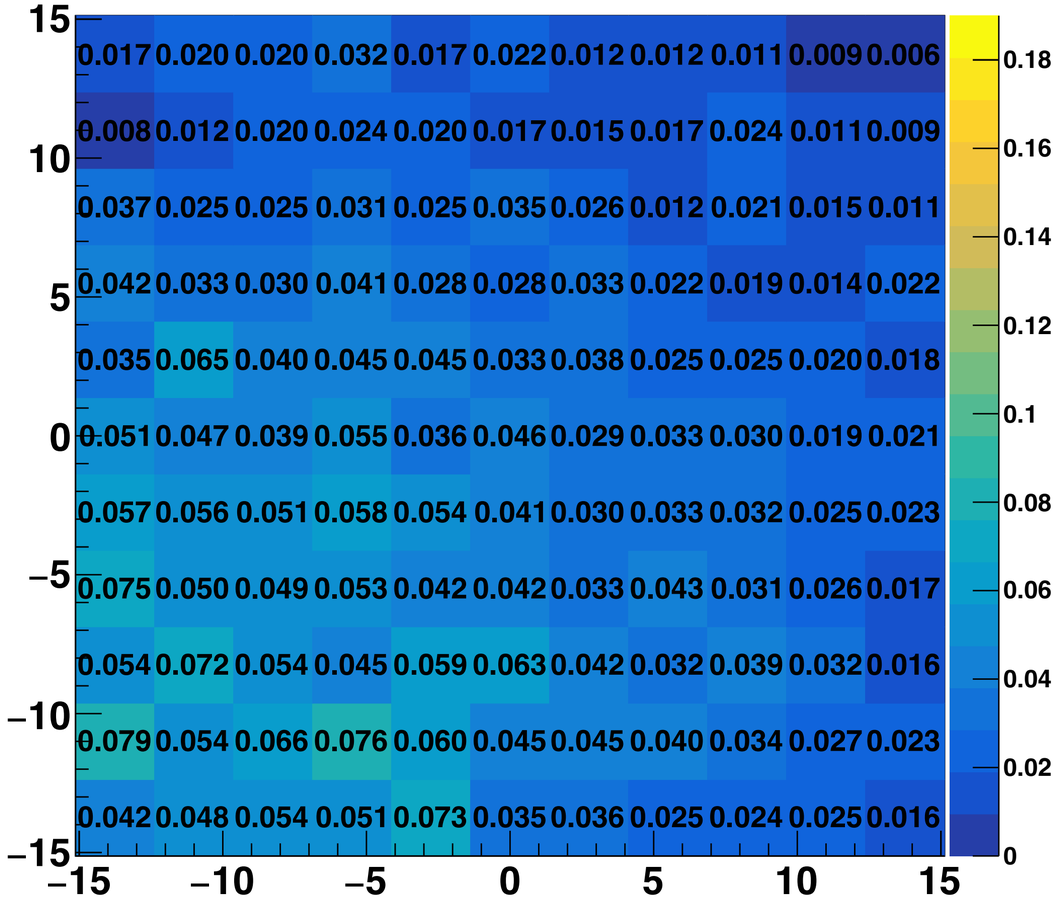


geometry 3 AIR



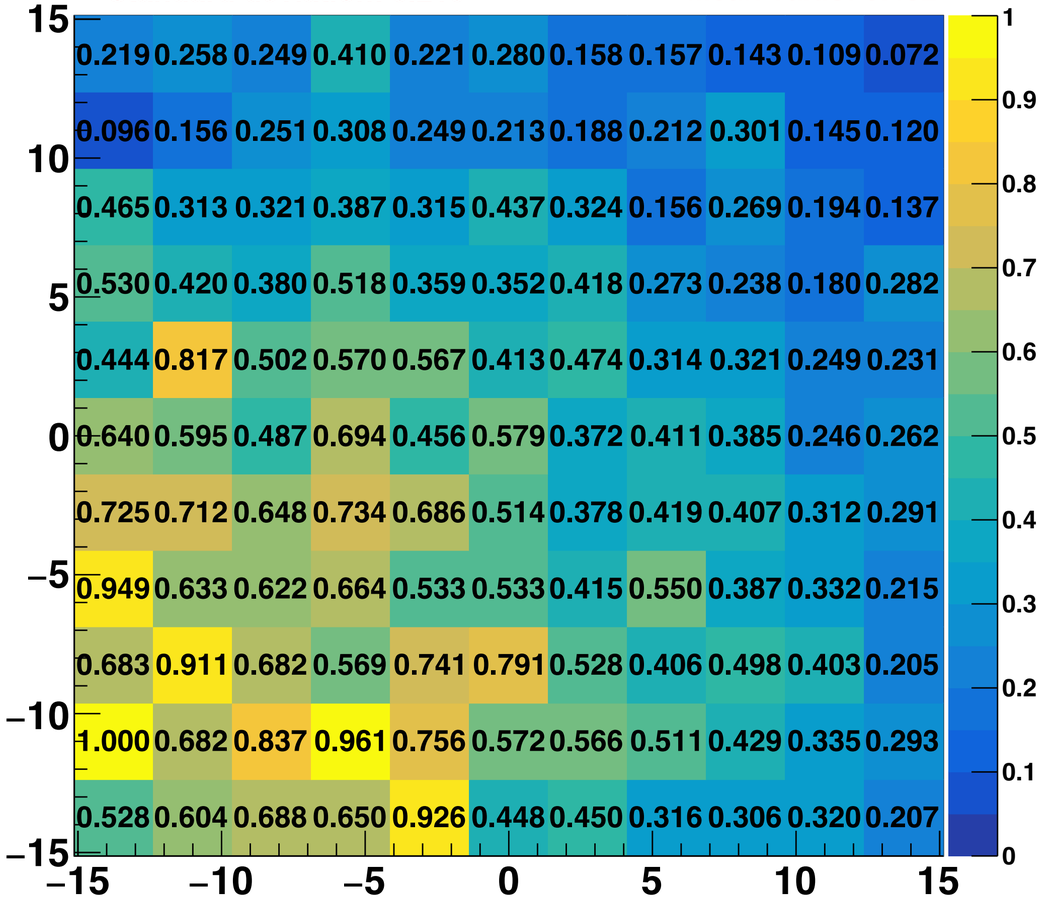
statistic 11.000 - muon 1 GeV

Efficiency - LG - Air - 3cm - base 8.9 mm

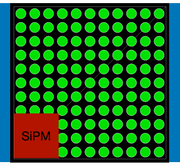


Factor non-uniformity - LG - AIR - 3cm - base 8.9 mm

Standard deviation: 0.210 **Mean value: 0.432**

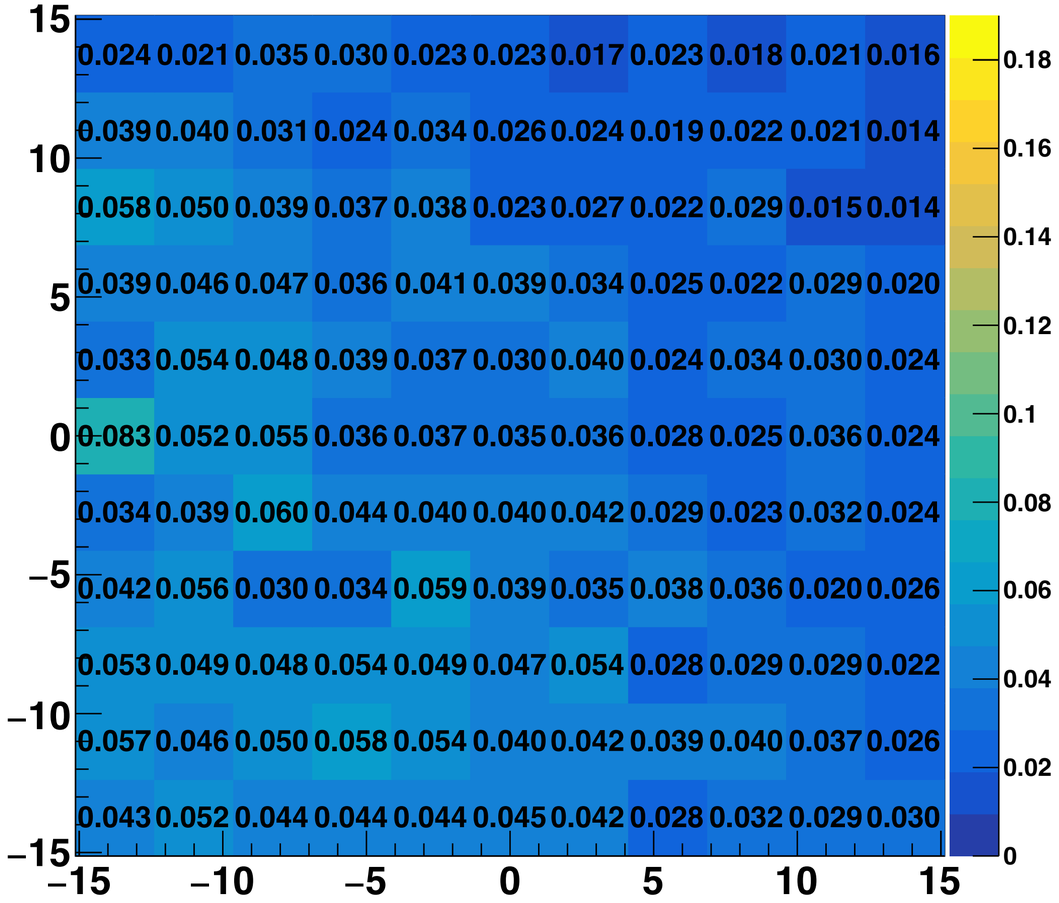


geometry 3 AIR



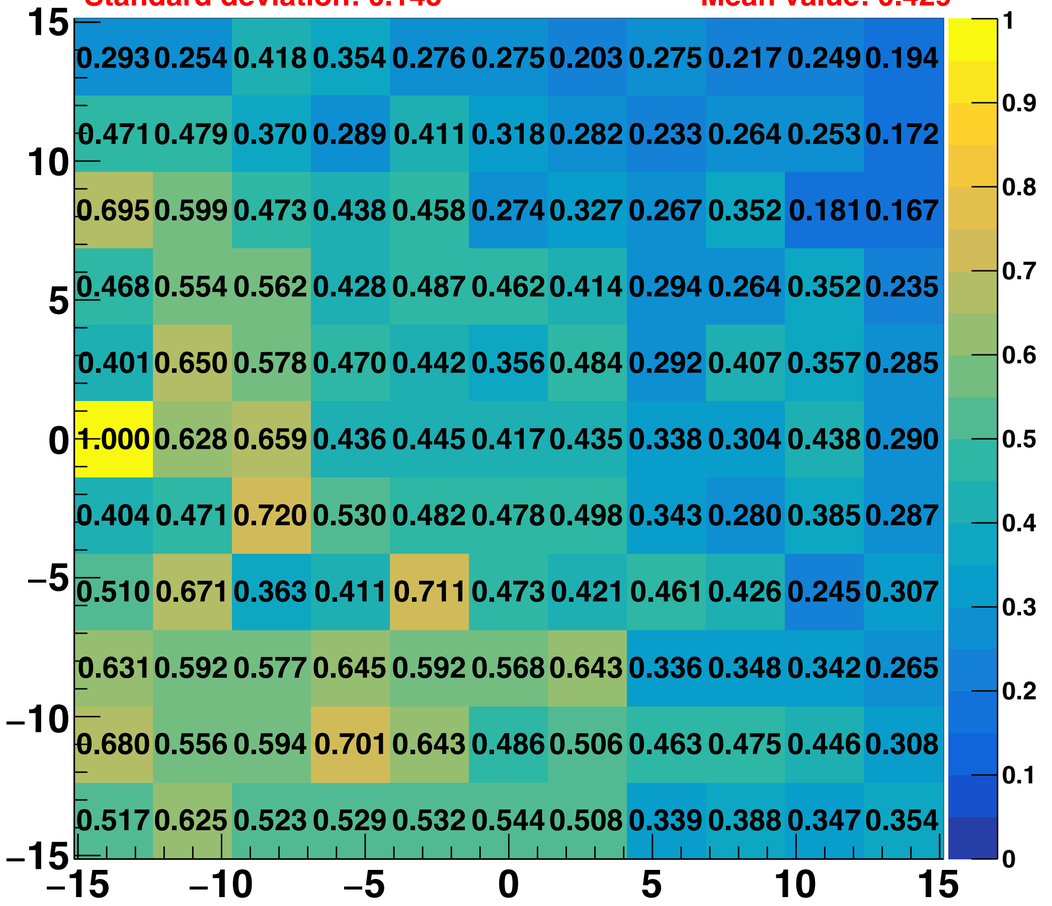
statistic 11.000 - muon 1 GeV

Efficiency - LG - Air - 4cm - base 8.9 mm

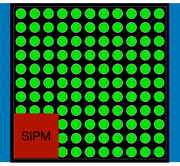


Factor non-uniformity - LG - AIR - 4cm - base 8.9 mm

Standard deviation: 0.145 **Mean value: 0.429**

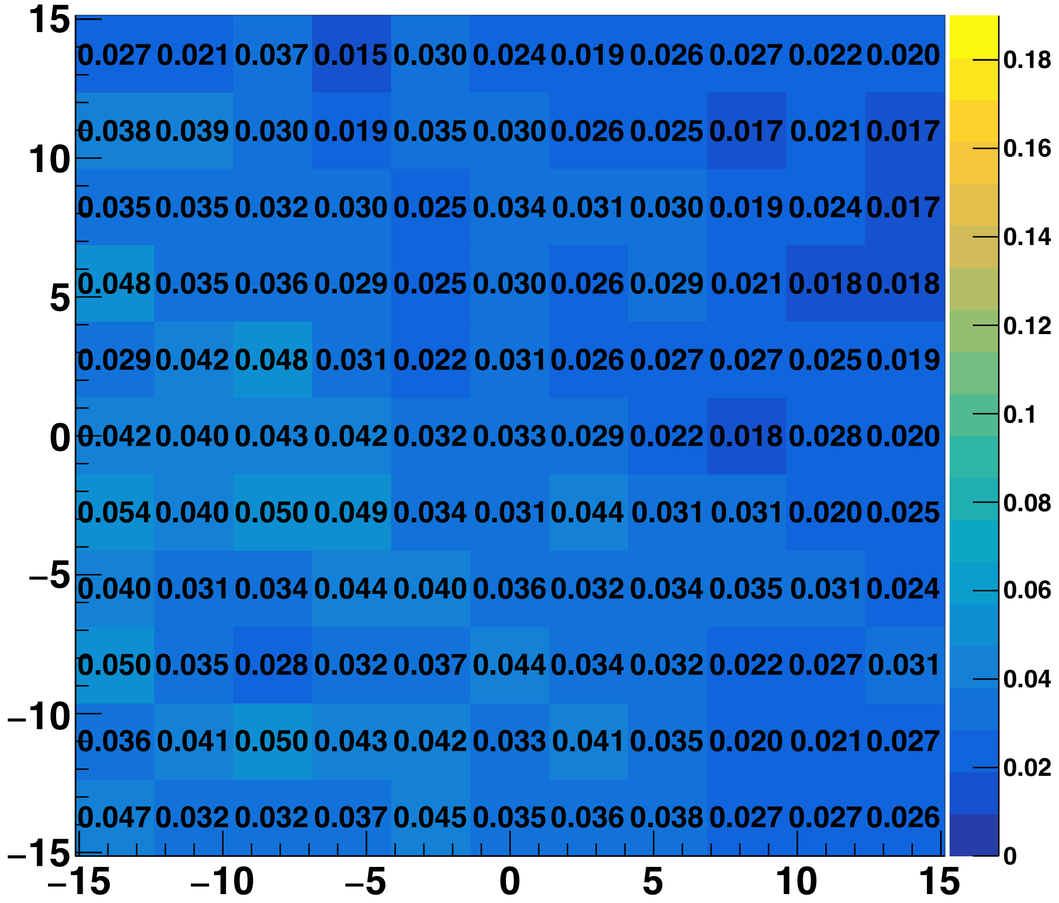


geometry 3 AIR

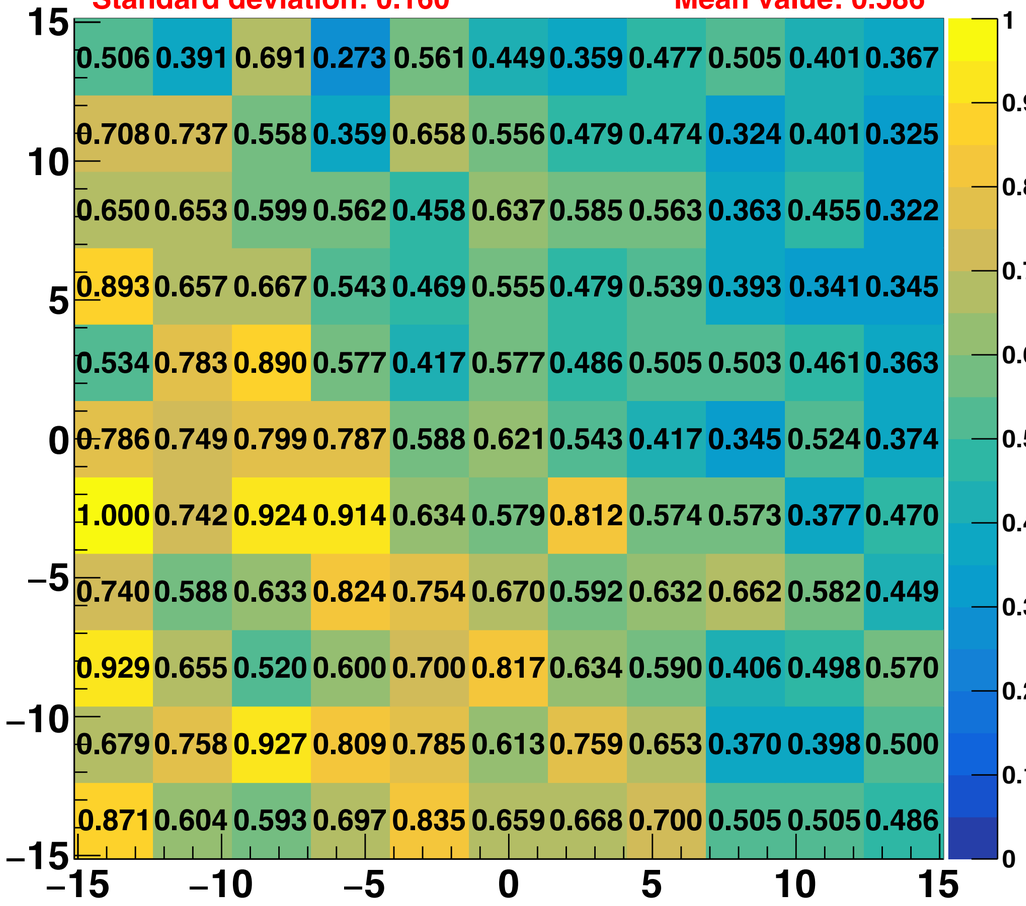


statistic 11.000 - muon 1 GeV

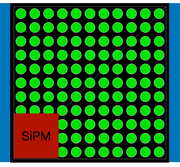
Efficiency - LG - Air - 5cm - base 8.9 mm



Factor non-uniformity - LG - AIR - 5cm - base 8.9 mm

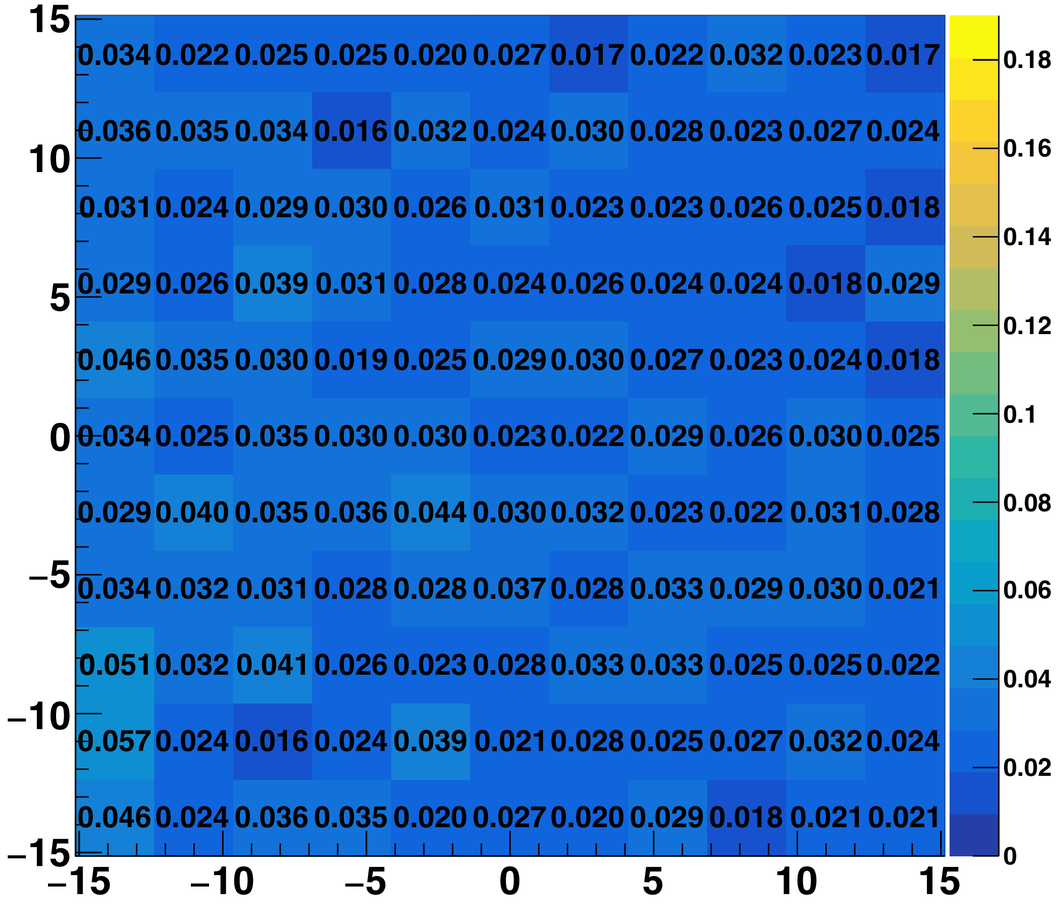


geometry 3 AIR



statistic 11.000 - muon 1 GeV

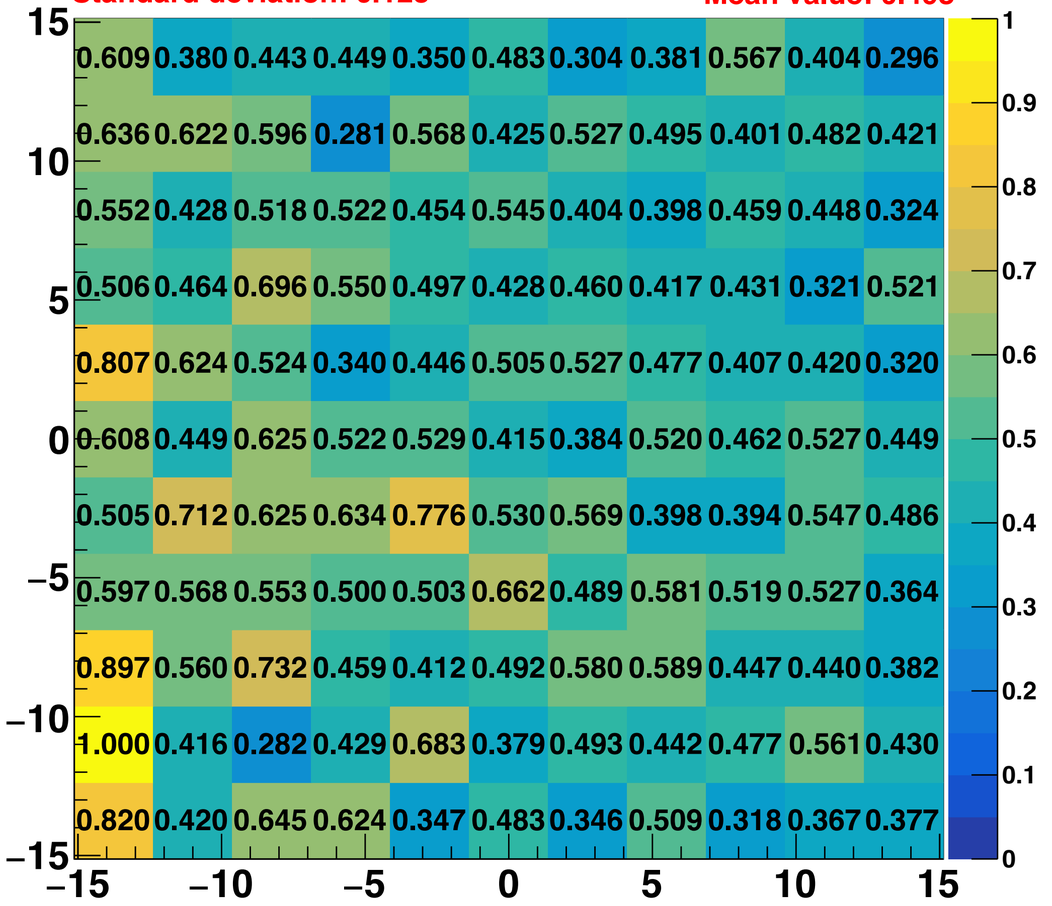
Efficiency - LG - Air - 6cm - base 8.9 mm

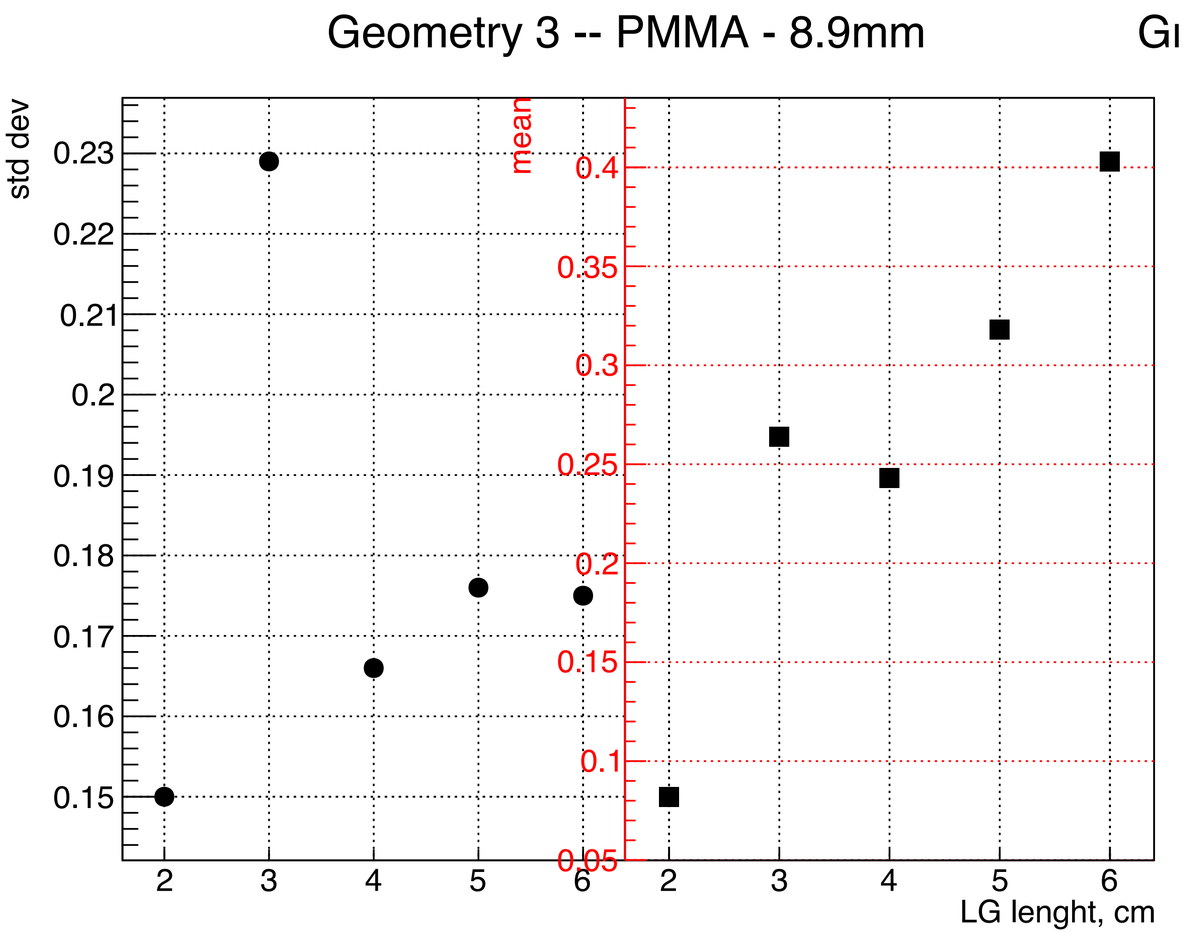


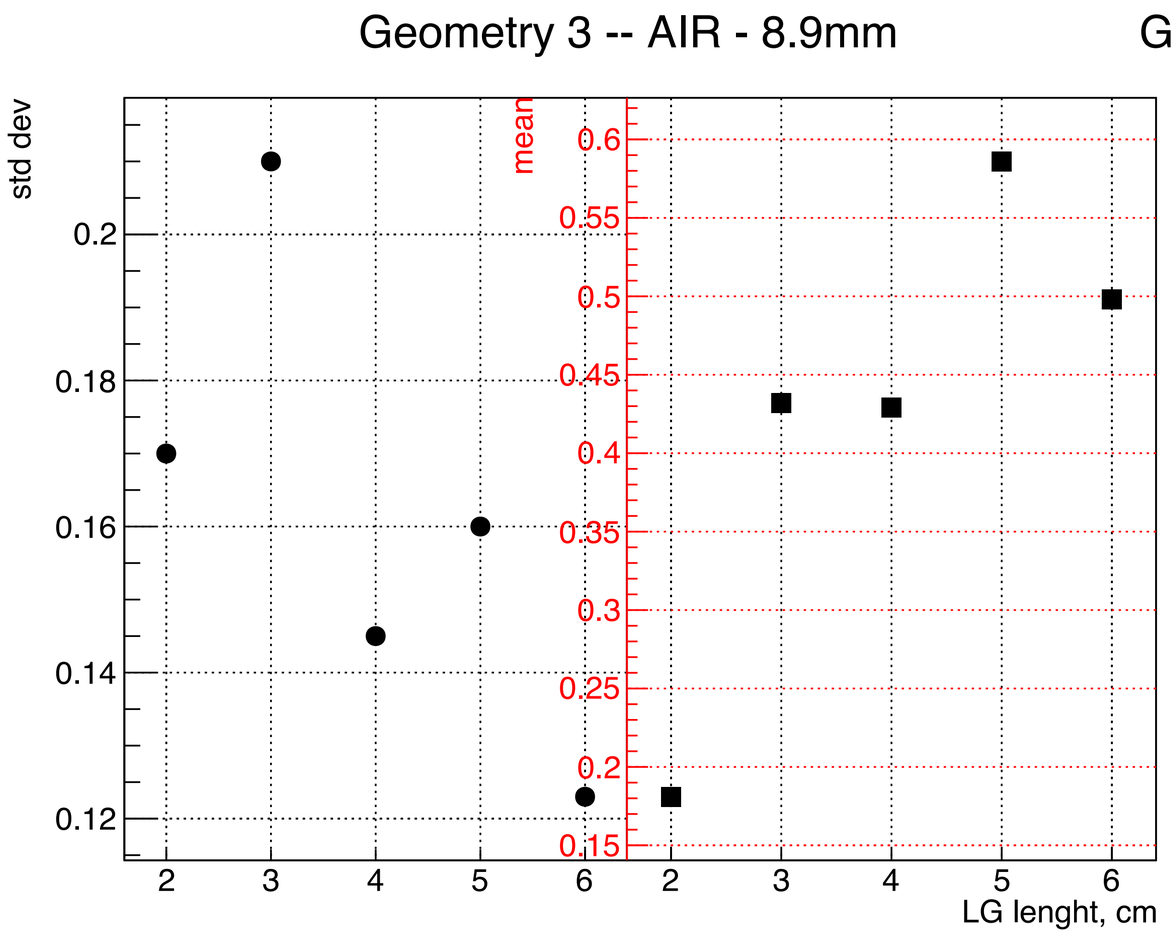
Factor non-uniformity - LG - AIR - 6cm - base 8.9 mm

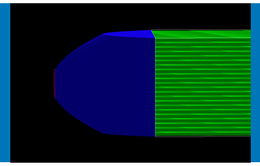
Standard deviation: 0.123

Mean value: 0.498



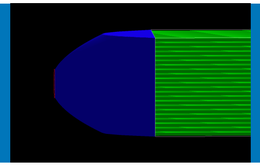

Geometry 3 -- PMMA - 8.9mm
std dev
mean
LG lenght, cm


Geometry 3 -- AIR - 8.9mm
std dev
mean
LG lenght, cm

- **Geometry 4.1** PMMA  statistic 11.000 - muon 1 GeV

Winstone cone
PMT 4.5

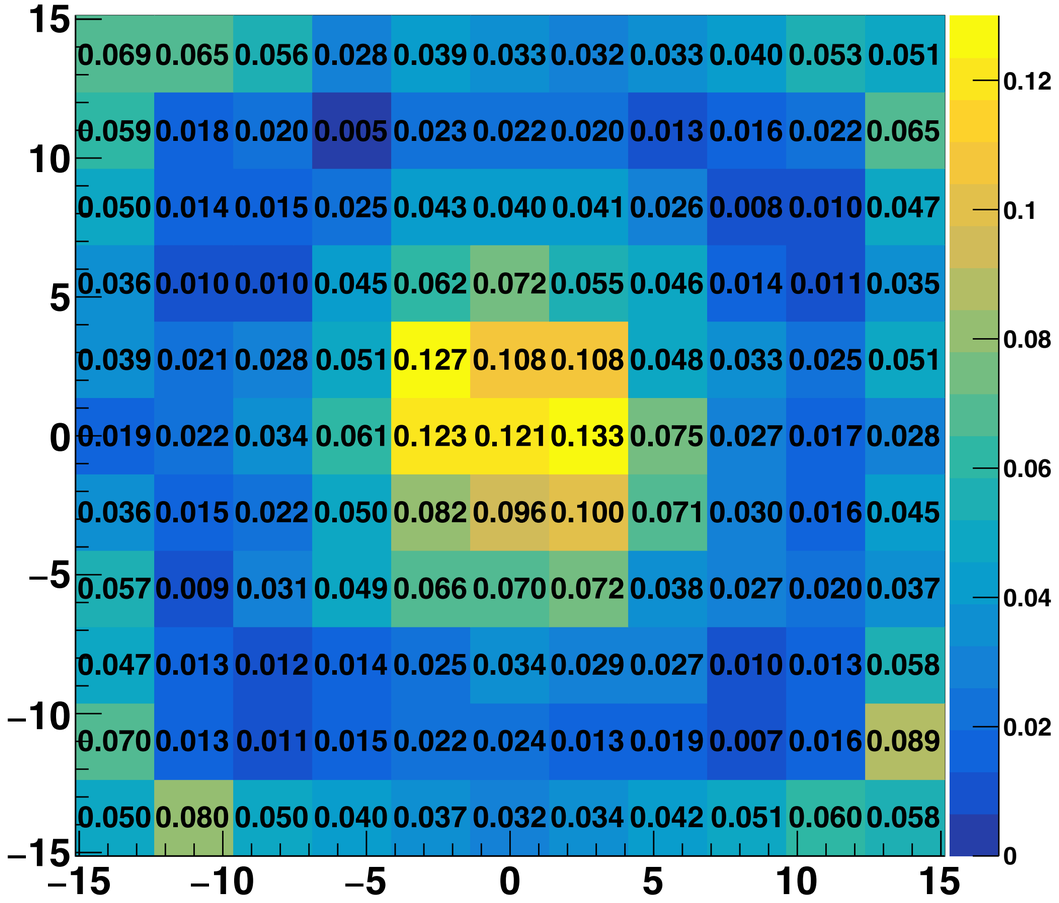
• Geometry 4 PMMA



statistic 11.000 - muon 1 GeV

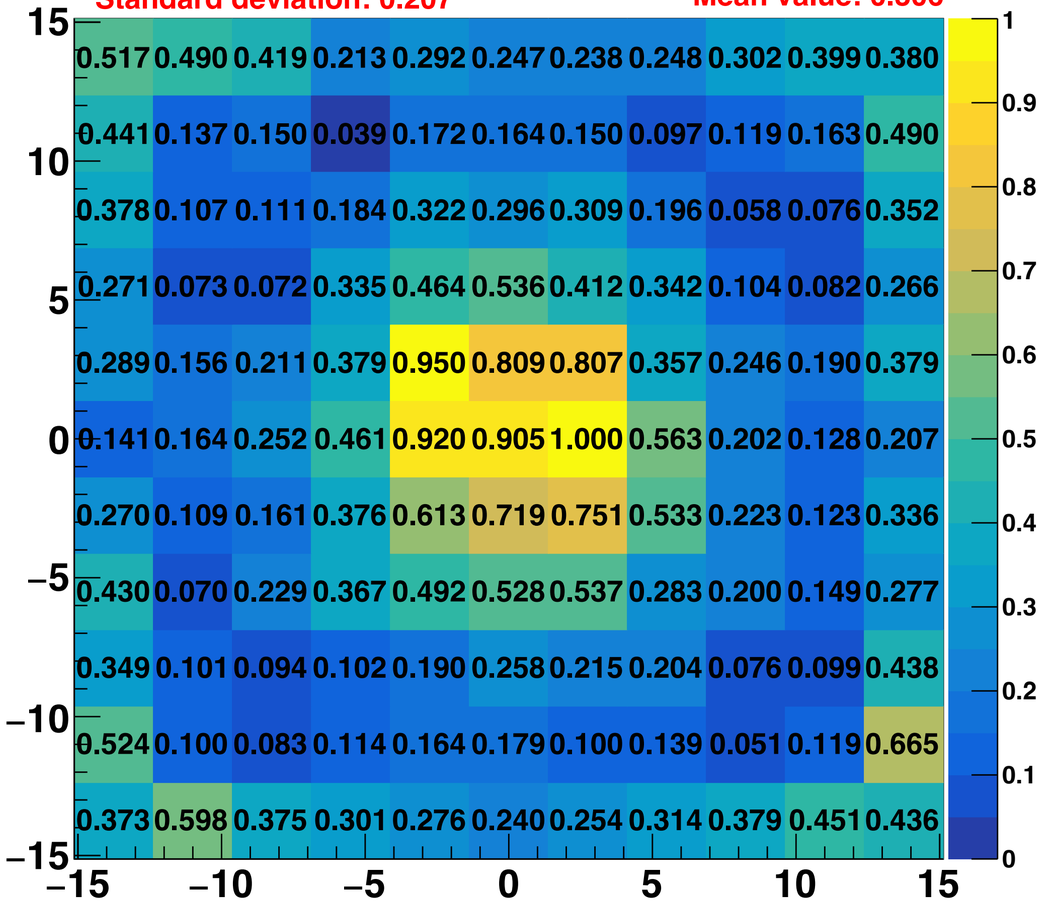
Winstone cone
PMT 4.5

Efficiency - LG - PMMA - 2cm - base round - 4.5 mm

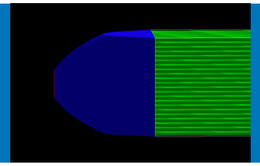


Factor non-uniformity - LG - PMMA - 2cm - base round - 4.5 mm

Standard deviation: 0.207 **Mean value: 0.306**



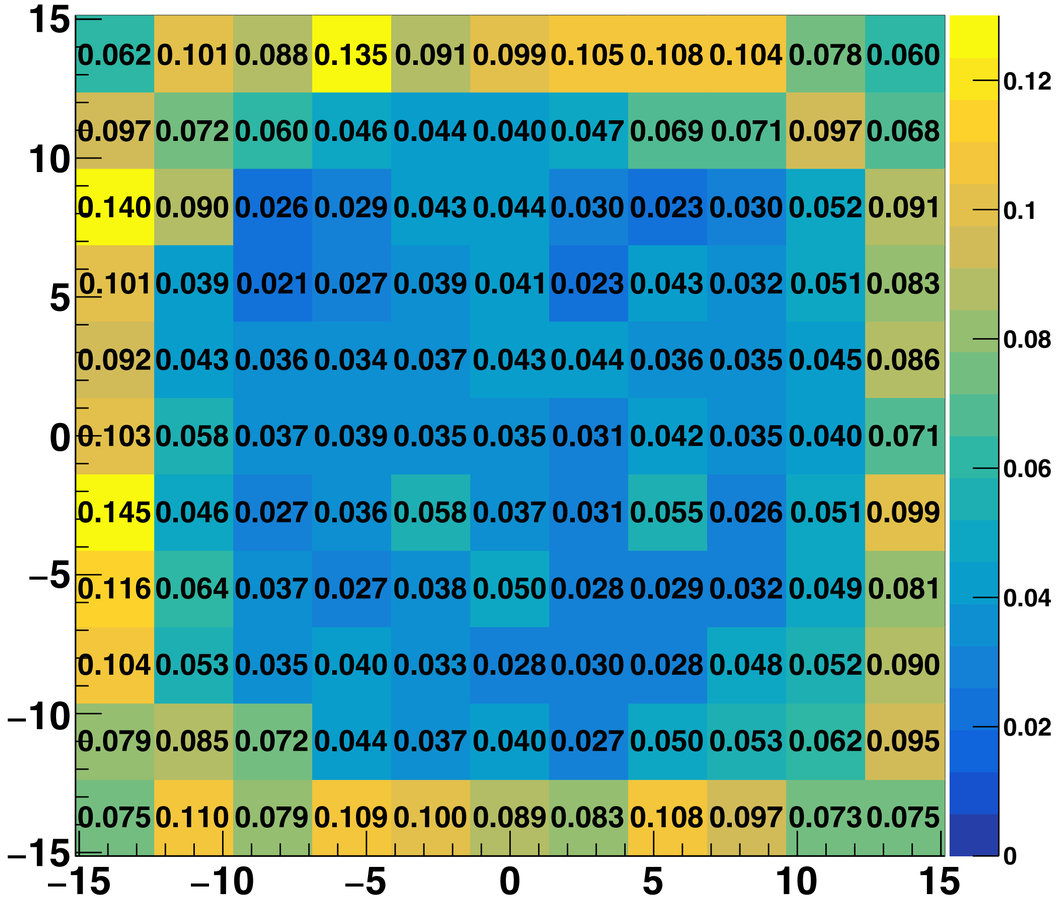
• Geometry 4 PMMA



statistic 11.000 - muon 1 GeV

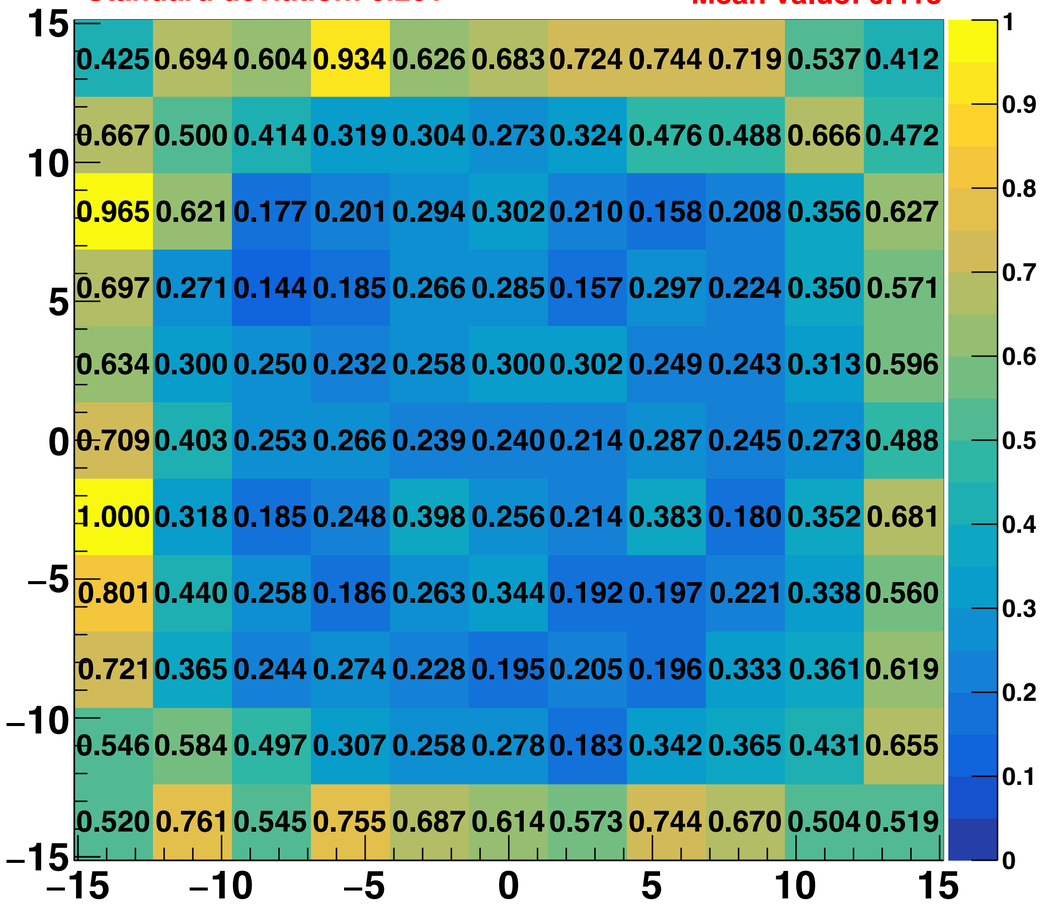
Winstone cone
PMT 4.5

Efficiency - LG - PMMA - 3cm - base round - 4.5 mm

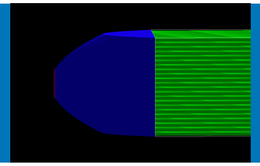


Factor non-uniformity - LG - PMMA - 3cm - base round - 4.5 mm

Standard deviation: 0.201 **Mean value: 0.413**



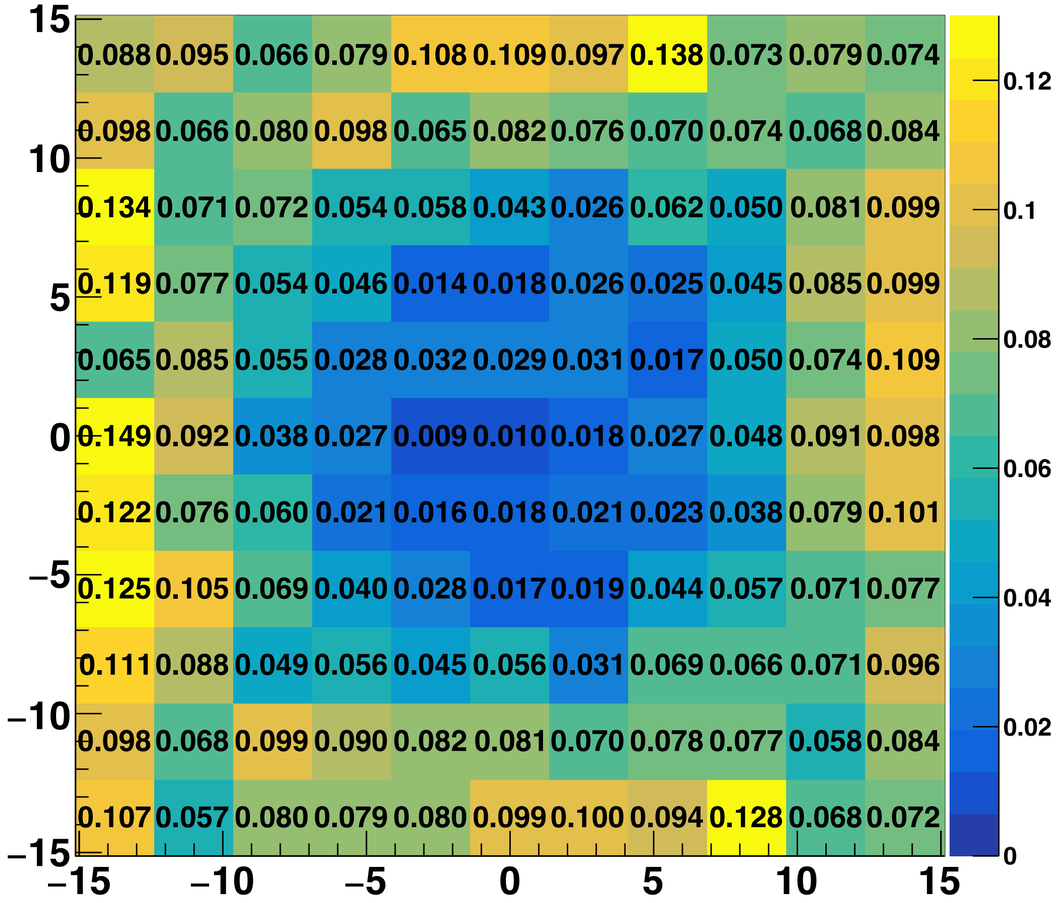
• Geometry 4 PMMA



statistic 11.000 - muon 1 GeV

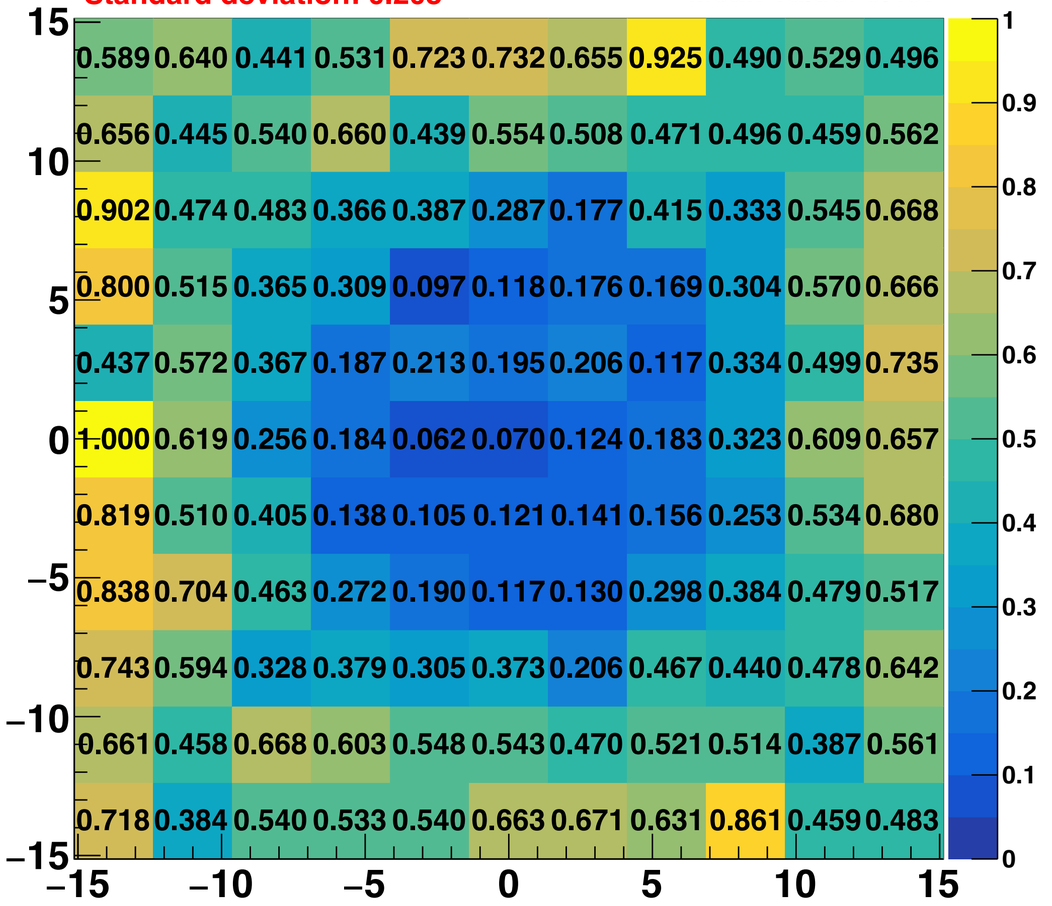
Winstone cone
PMT 4.5

Efficiency - LG - PMMA - 4cm - base round - 4.5 mm

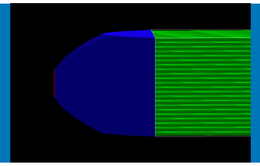


Factor non-uniformity - LG - PMMA - 4cm - base round - 4.5 mm

Standard deviation: 0.208 **Mean value: 0.457**



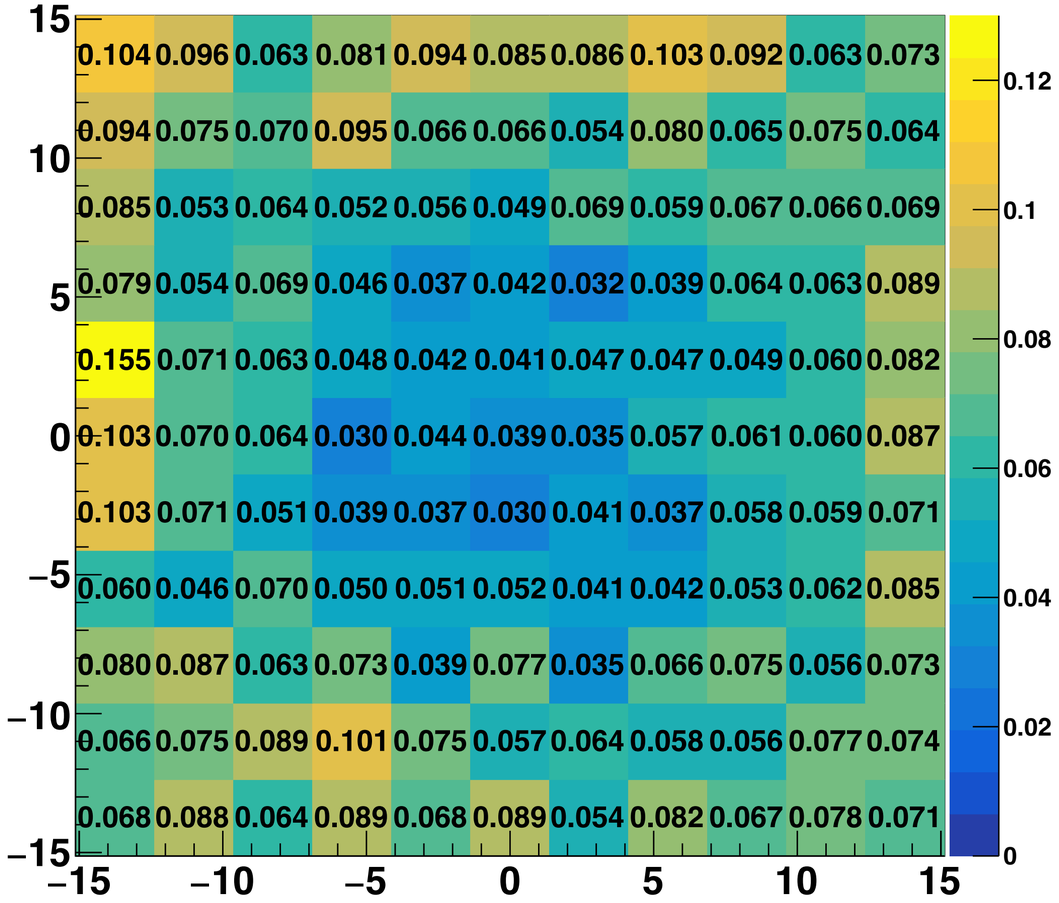
• Geometry 4 PMMA



statistic 11.000 - muon 1 GeV

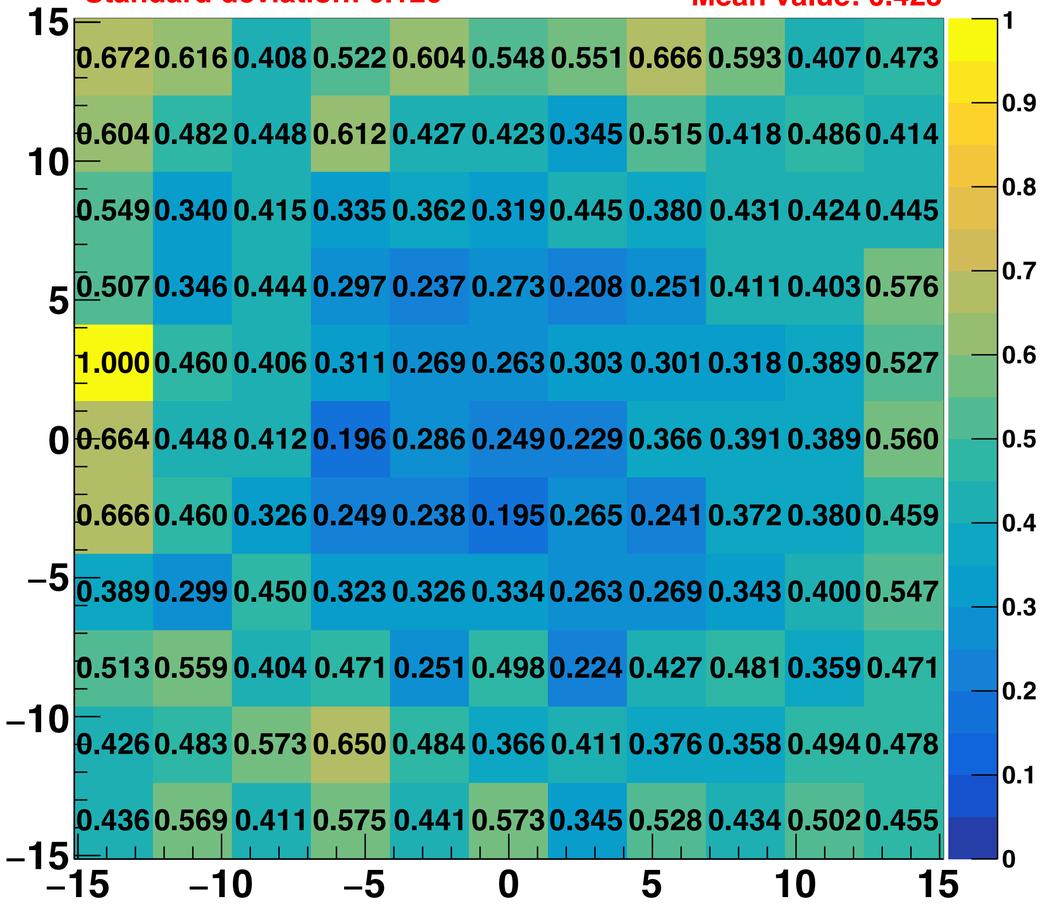
Winstone cone
PMT 4.5

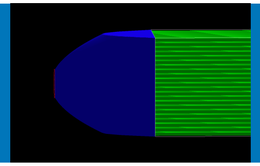
Efficiency - LG - PMMA - 5cm - base round - 4.5 mm



Factor non-uniformity - LG - PMMA - 5cm - base round - 4.5 mm

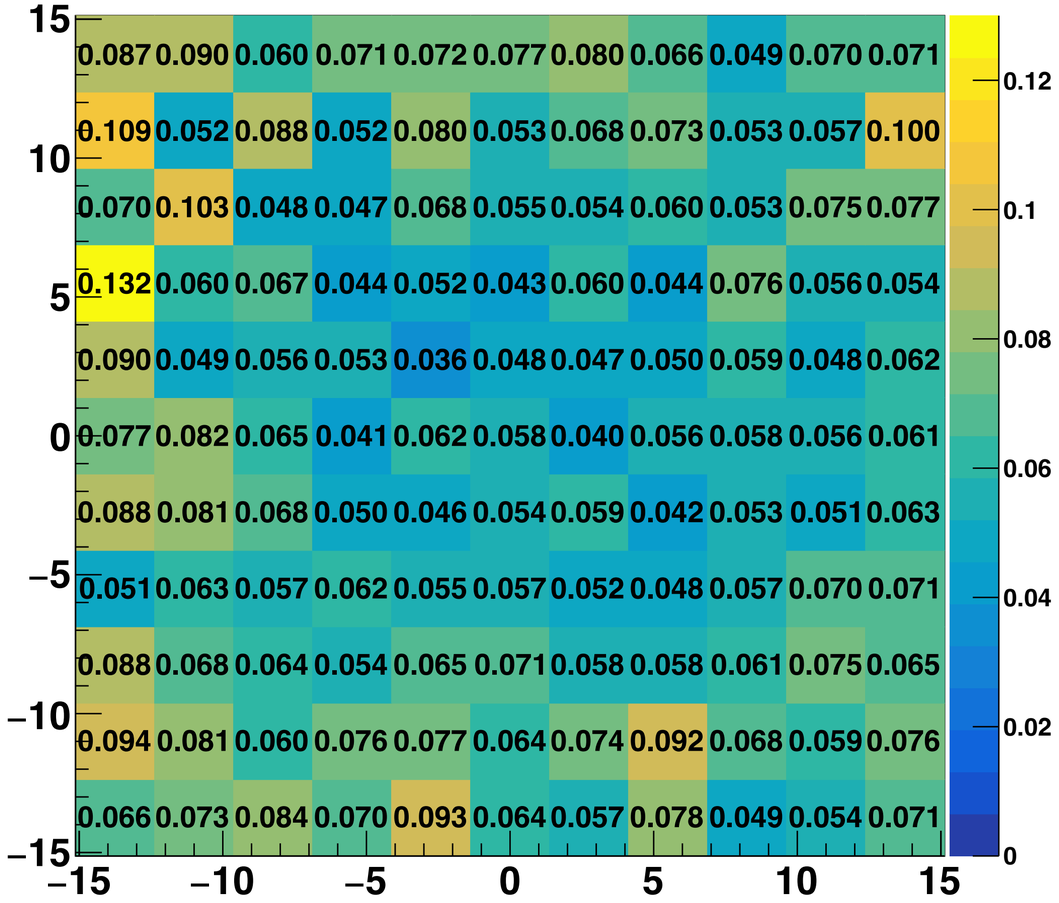
Standard deviation: 0.126 **Mean value: 0.423**



• Geometry 4 PMMA  statistic 11.000 - muon 1 GeV

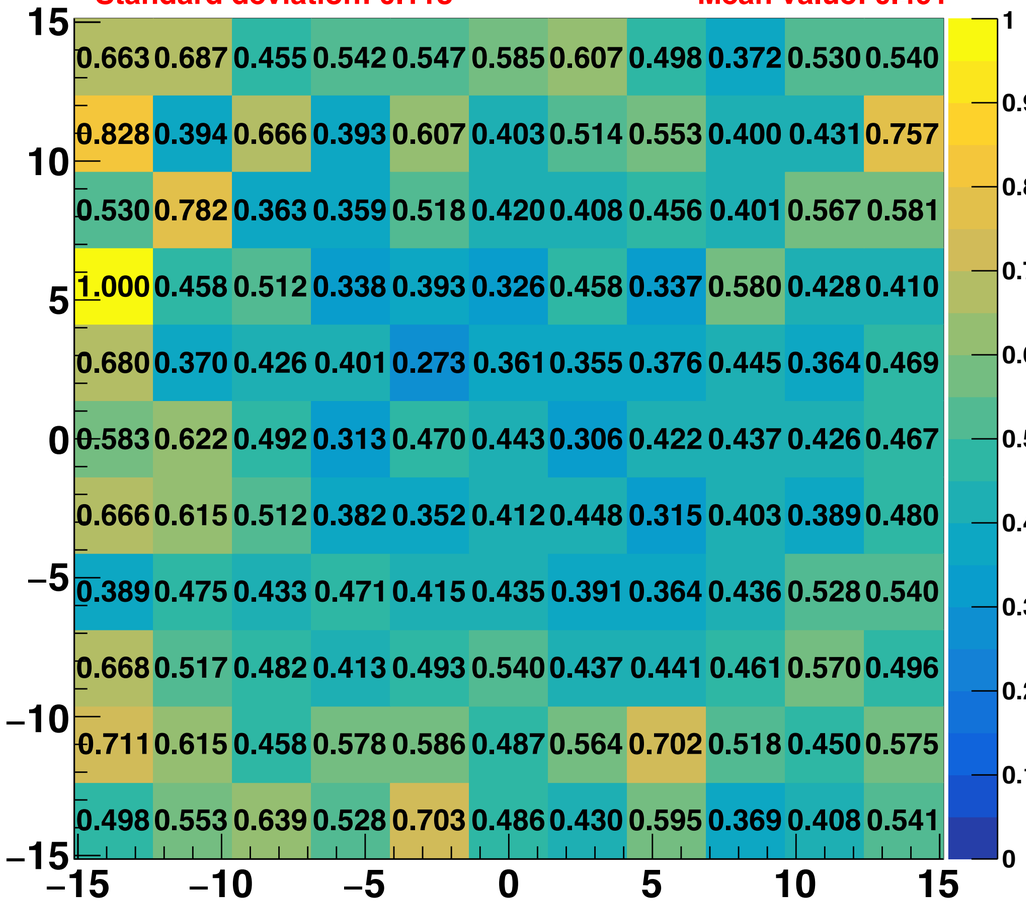
Winstone cone
PMT 4.5

Efficiency - LG - PMMA - 6cm - base round - 4.5 mm

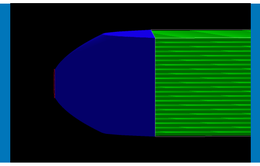


Factor non-uniformity - LG - PMMA - 6cm - base round - 4.5 mm

Standard deviation: 0.118 **Mean value: 0.491**



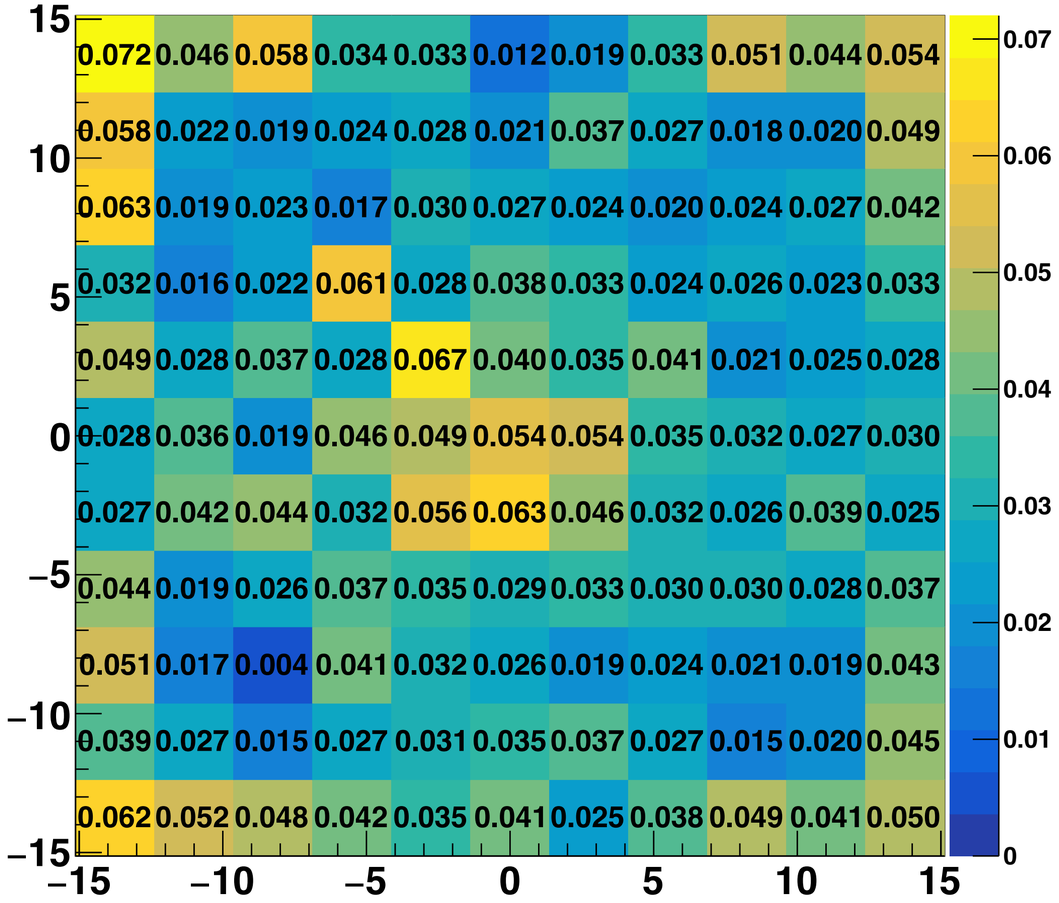
• Geometry 4 AIR



statistic 11.000 - muon 1 GeV

Winstone cone
PMT 4.5

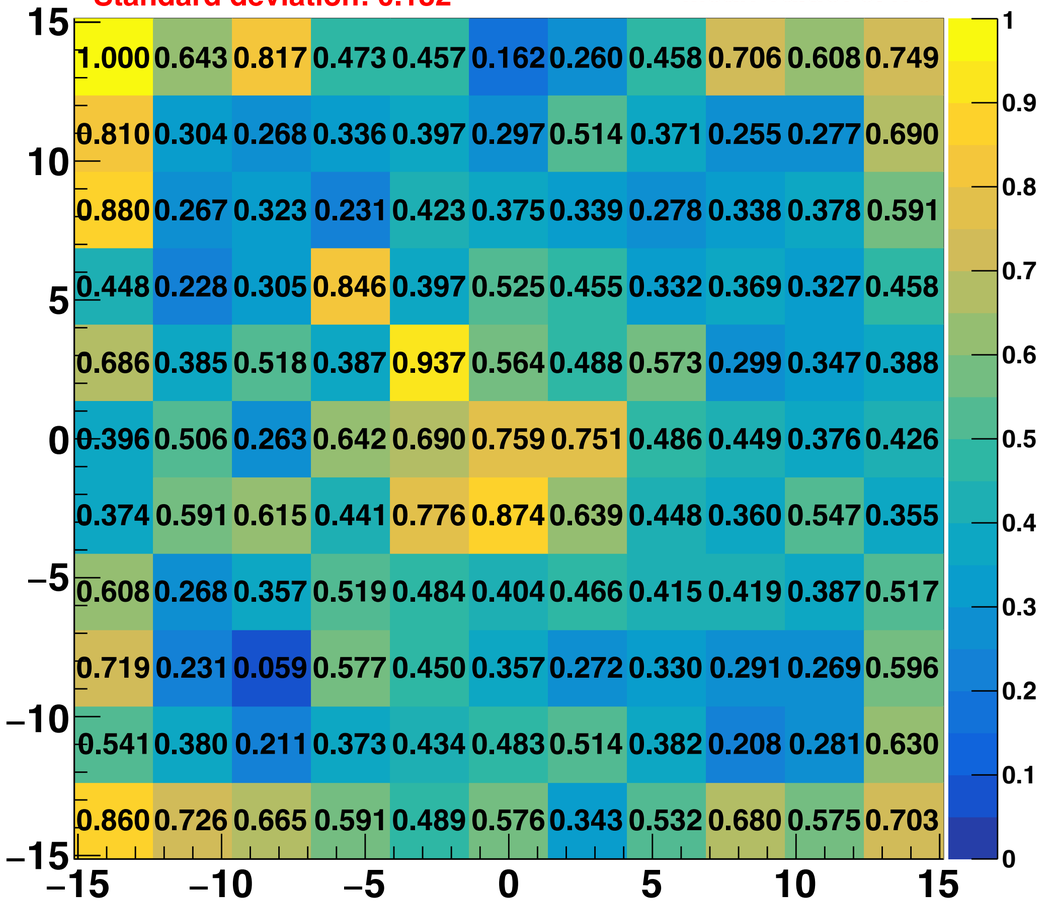
Efficiency - LG - Air - 2cm - base round - 4.5 mm



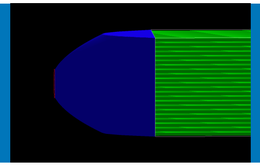
Factor non-uniformity - LG - Air - 2cm - base round - 4.5 mm

Standard deviation: 0.182

Mean value: 0.475



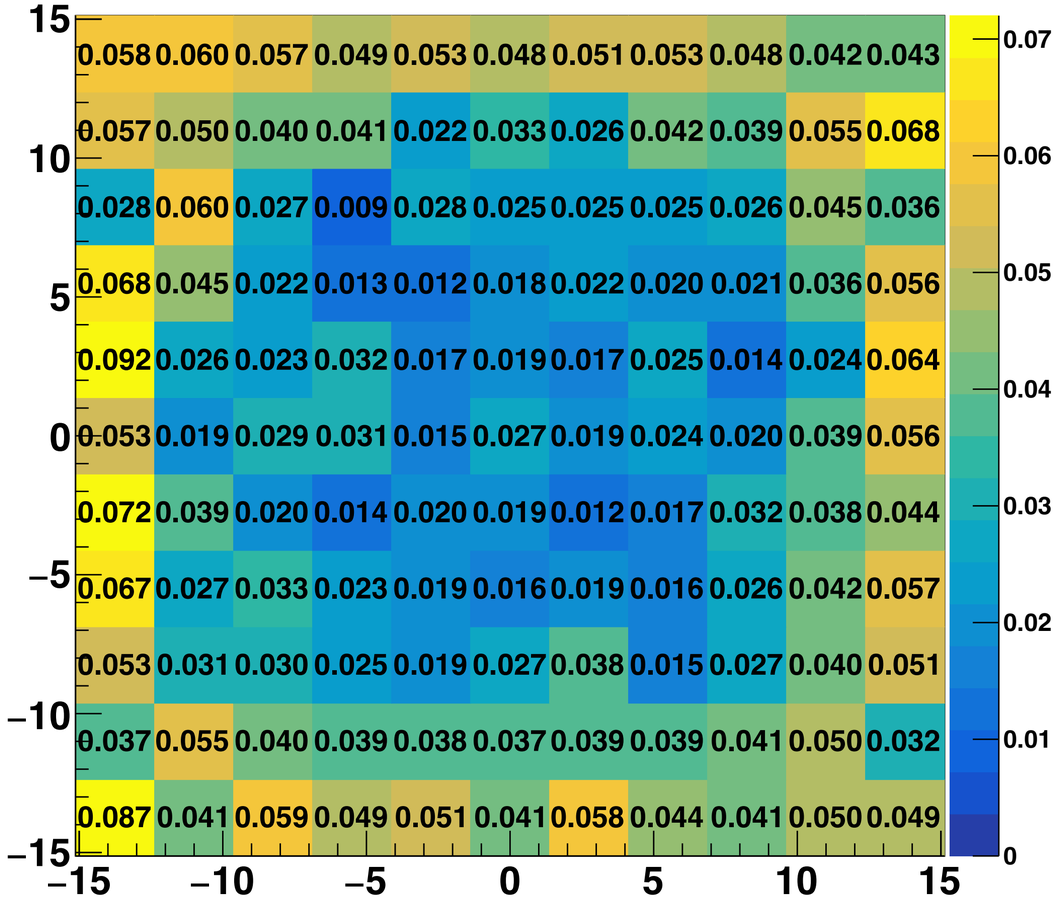
• Geometry 4 AIR



statistic 11.000 - muon 1 GeV

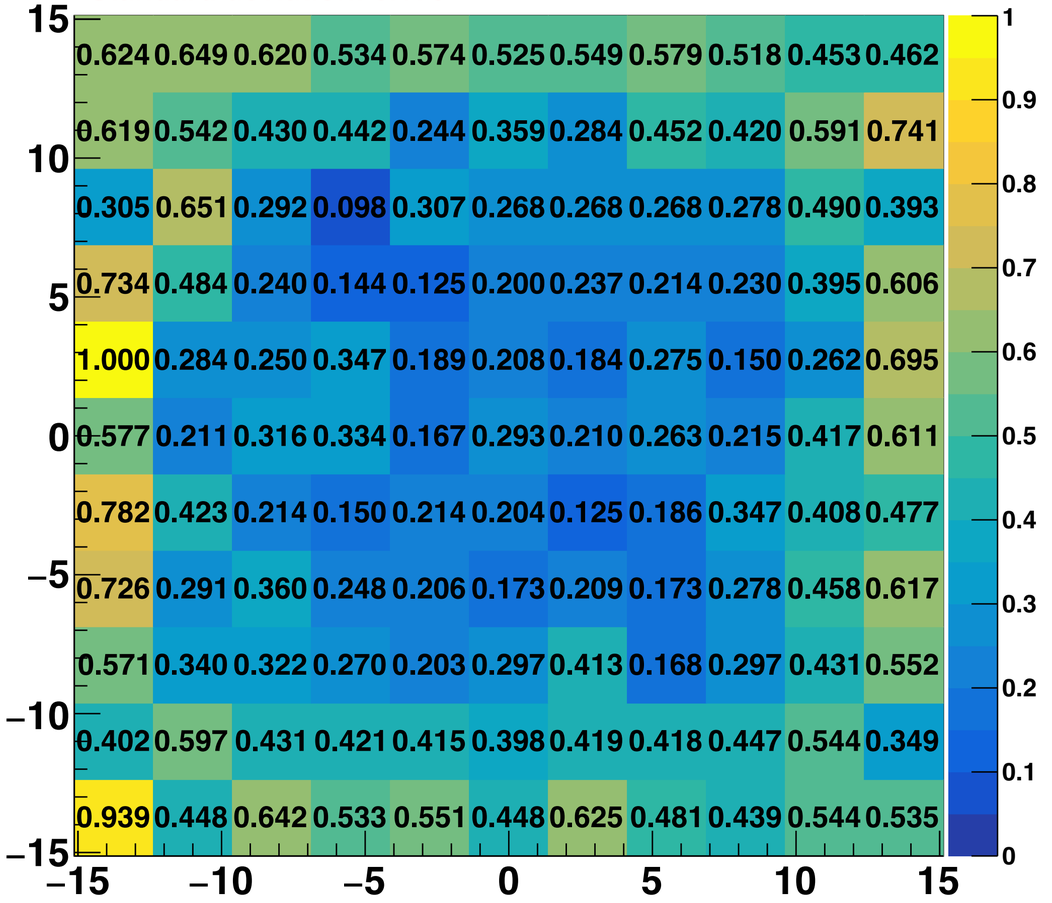
Winstone cone
PMT 4.5

Efficiency - LG - Air - 3cm - base round - 4.5 mm

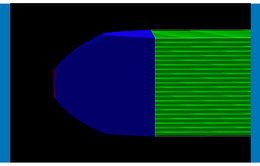


Factor non-uniformity - LG - Air - 3cm - base round - 4.5 mm

Standard deviation: 0.179 **Mean value: 0.397**



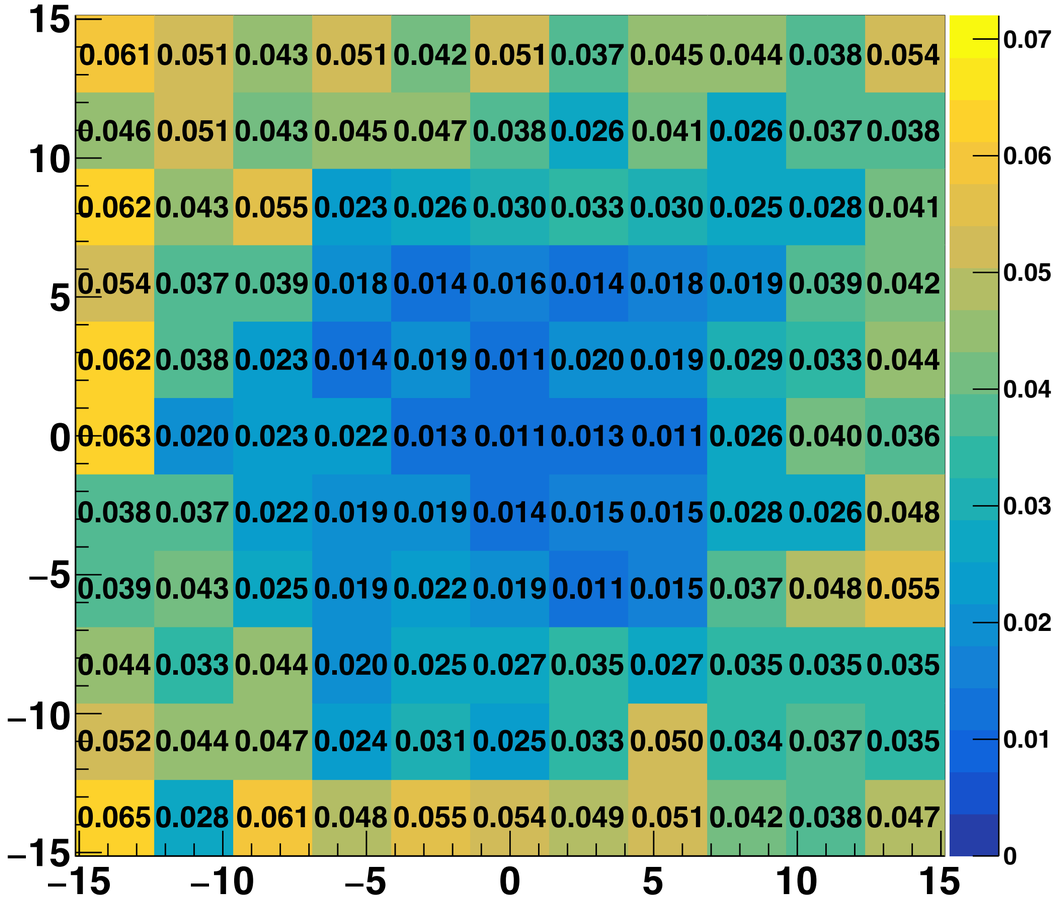
• Geometry 4 AIR



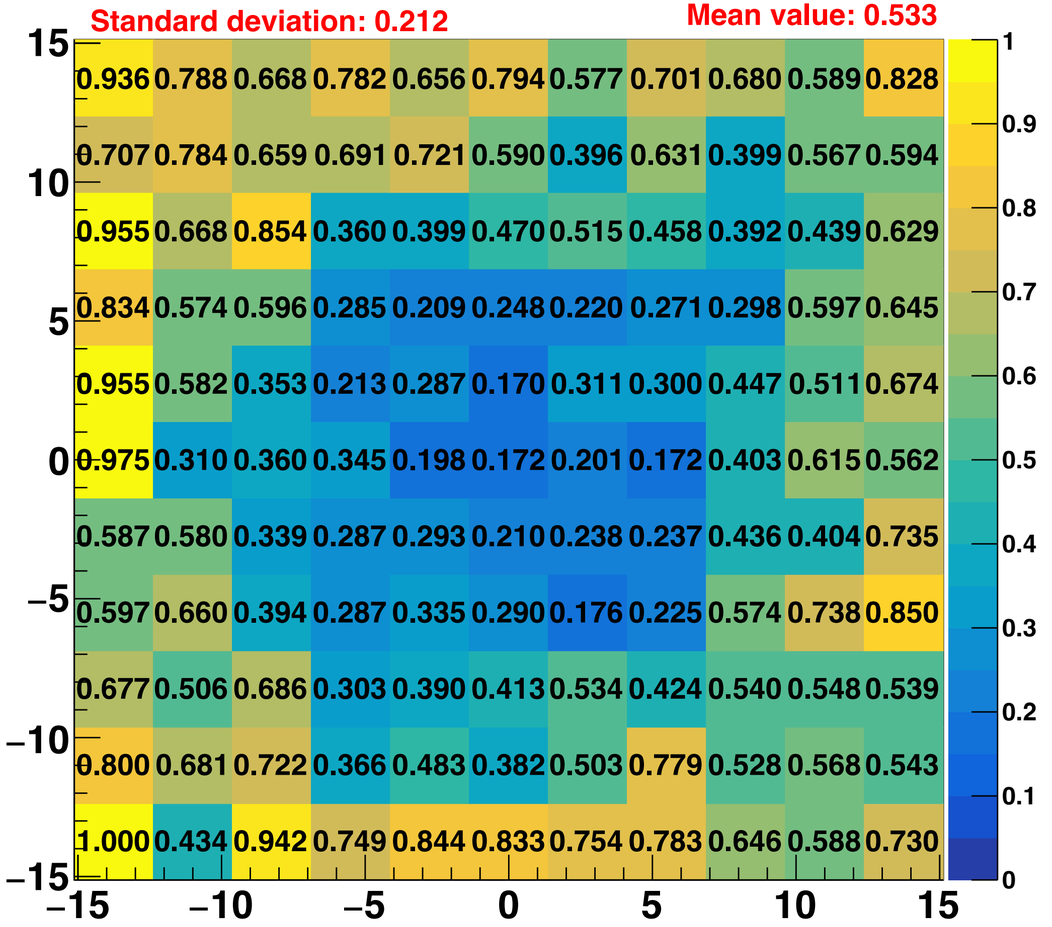
statistic 11.000 - muon 1 GeV

Winstone cone
PMT 4.5

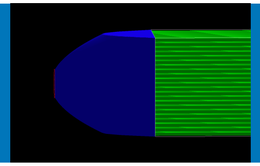
Efficiency - LG - Air - 4cm - base round - 4.5 mm



Factor non-uniformity - LG - Air - 4cm - base round - 4.5 mm



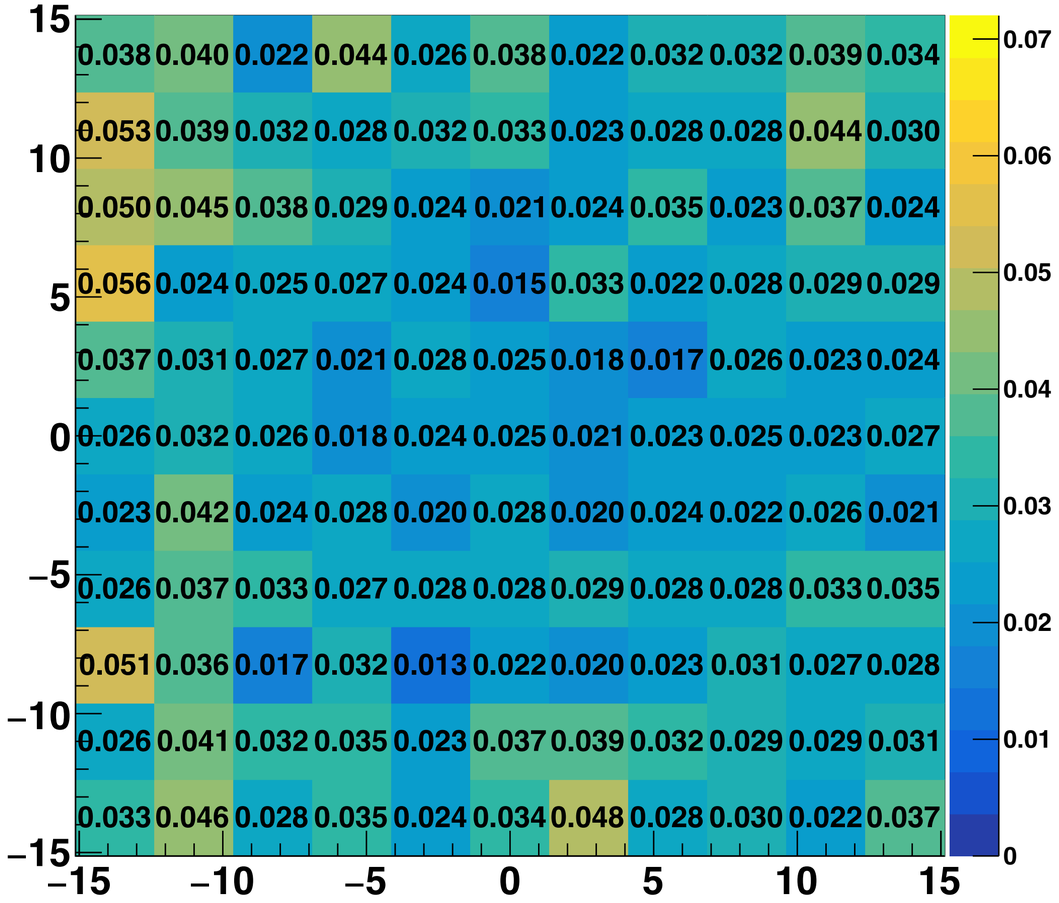
• Geometry 4 AIR



statistic 11.000 - muon 1 GeV

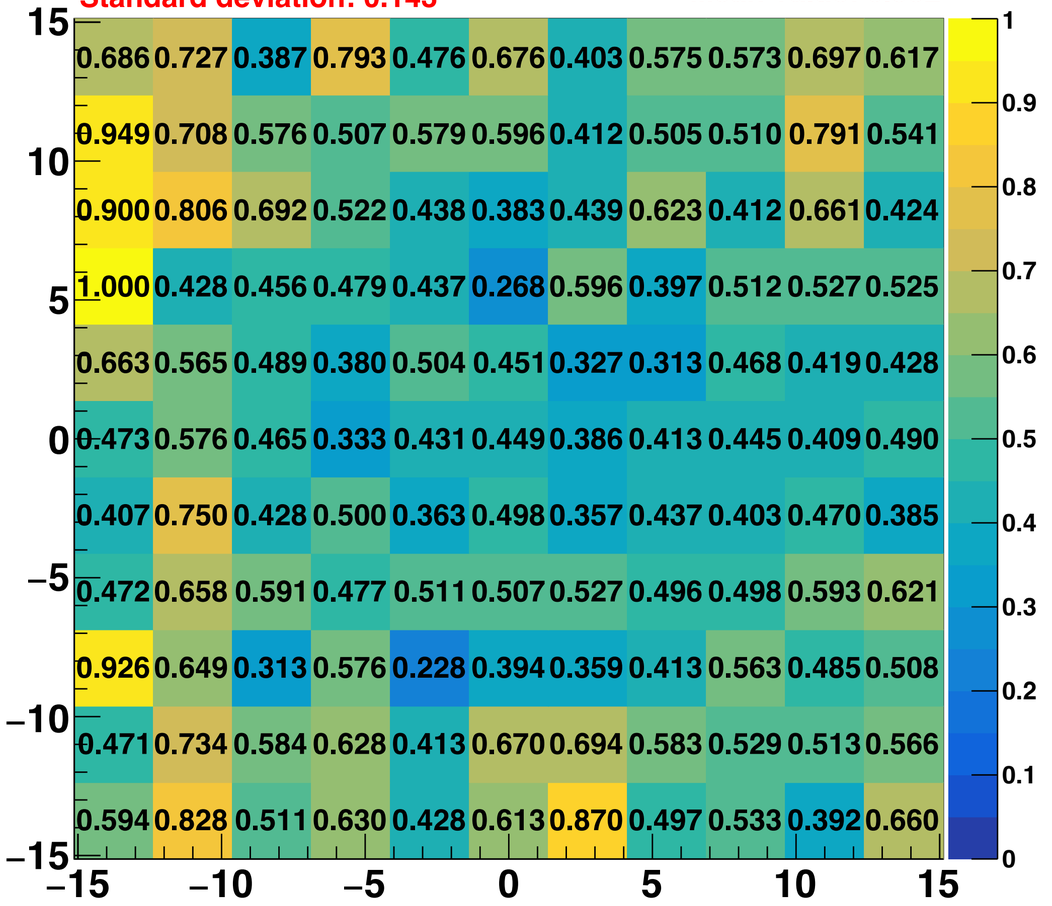
Winstone cone
PMT 4.5

Efficiency - LG - Air - 5cm - base round - 4.5 mm

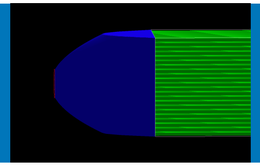


Factor non-uniformity - LG - Air - 5cm - base round - 4.5 mm

Standard deviation: 0.143 **Mean value: 0.532**



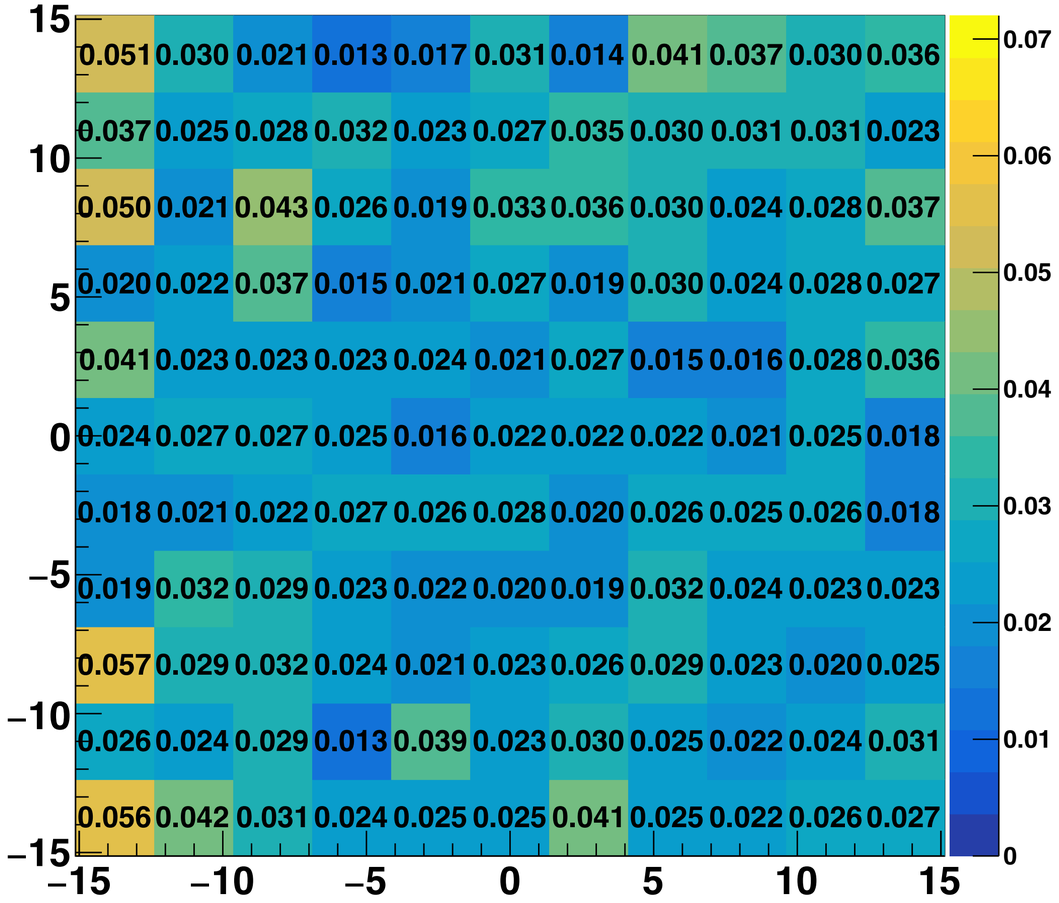
• Geometry 4 AIR



statistic 11.000 - muon 1 GeV

Winstone cone
PMT 4.5

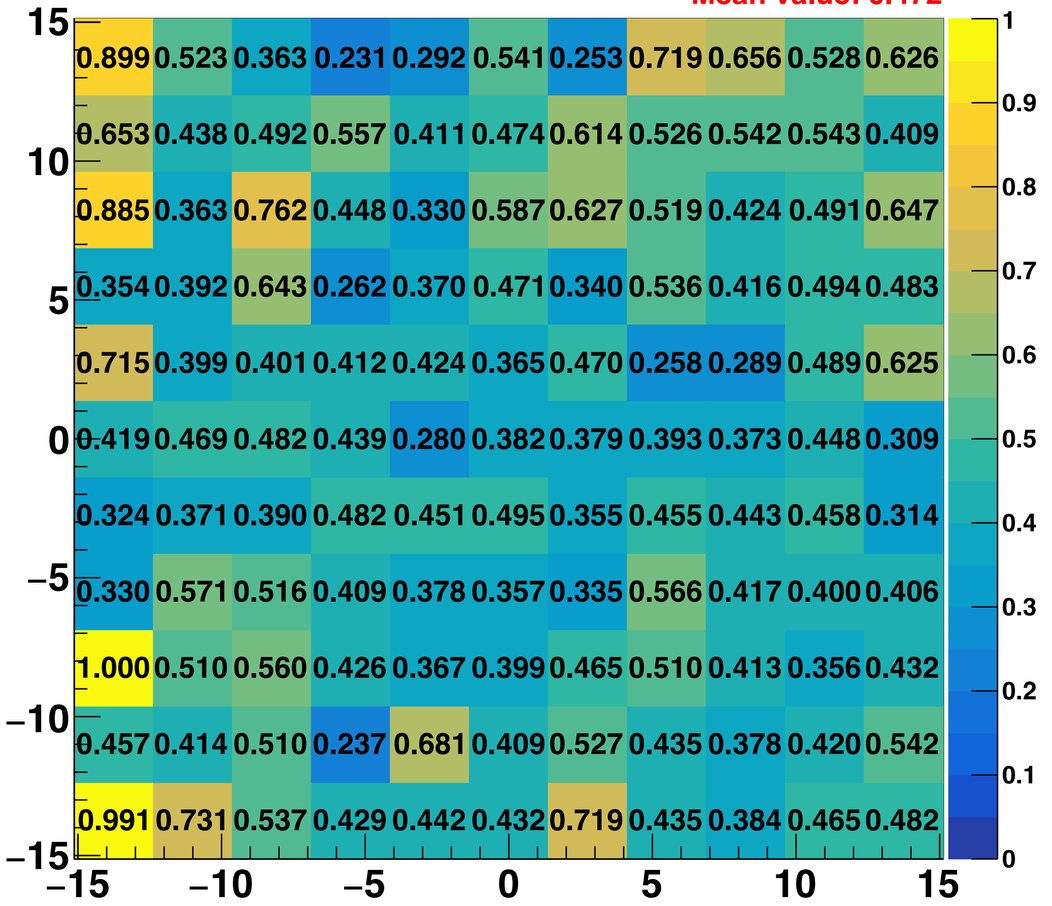
Efficiency - LG - Air - 6cm - base round - 4.5 mm

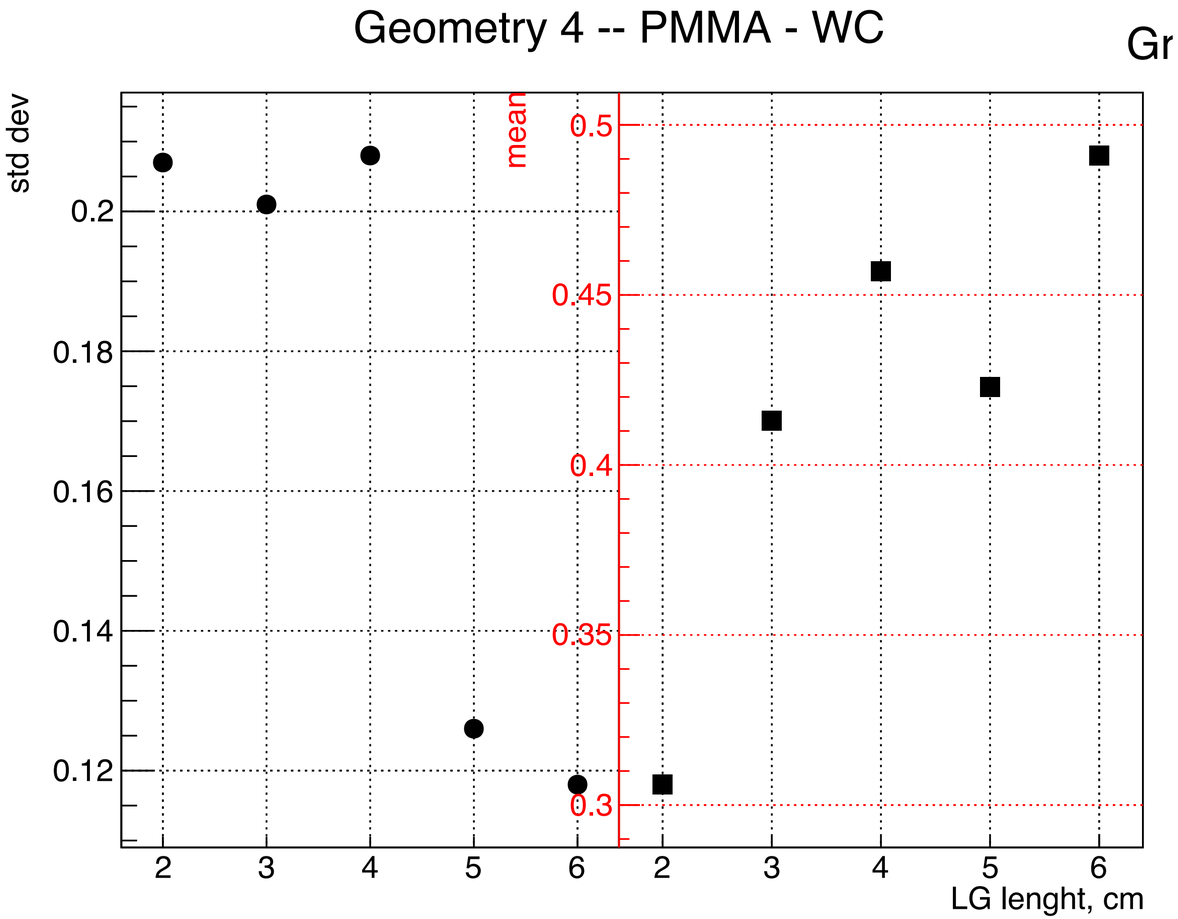


Factor non-uniformity - LG - Air - 6cm - base round - 4.5 mm

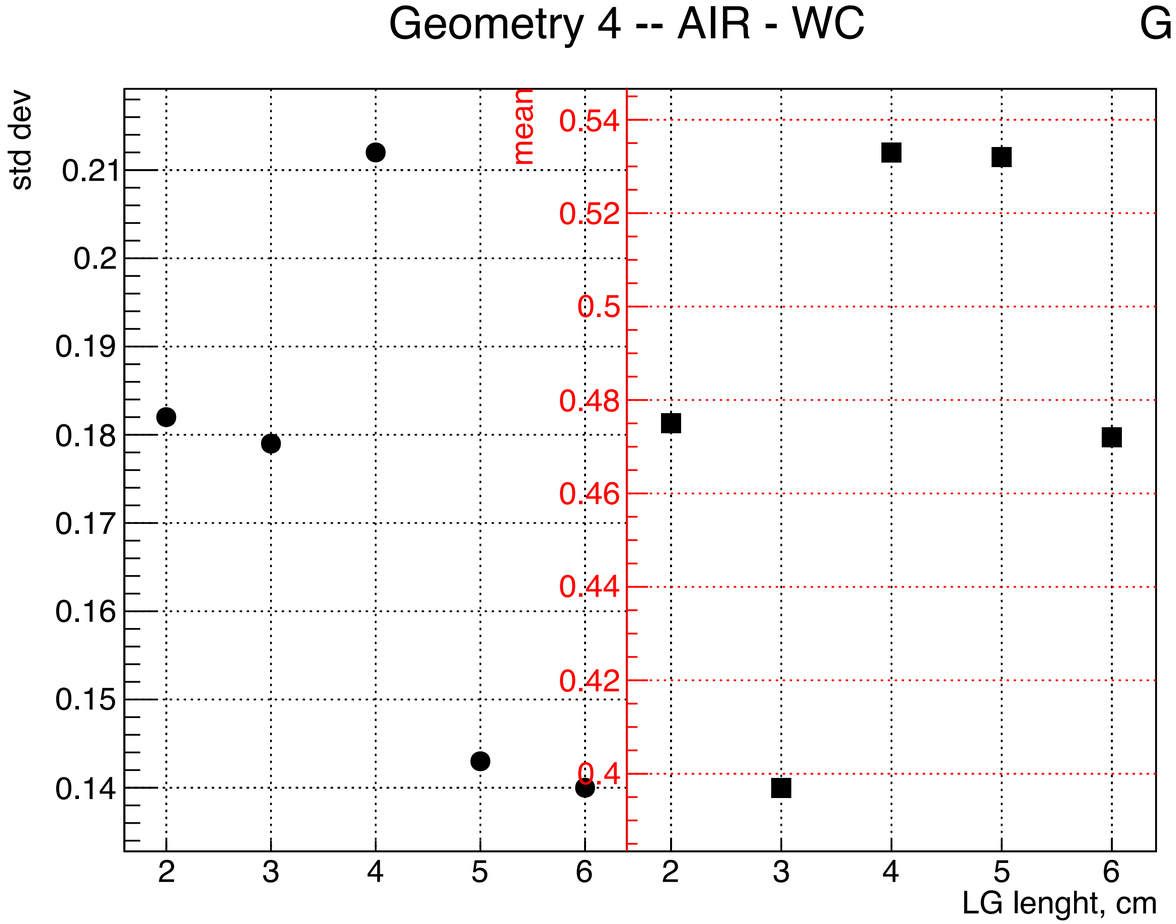
Standard deviation: 0.140

Mean value: 0.472

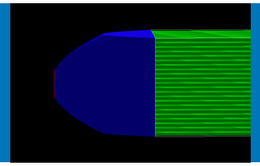



Geometry 4 -- PMMA - WC
std dev
mean
LG lenght, cm

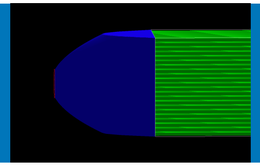
Gr


Geometry 4 -- AIR - WC
std dev
mean
LG lenght, cm

Graph

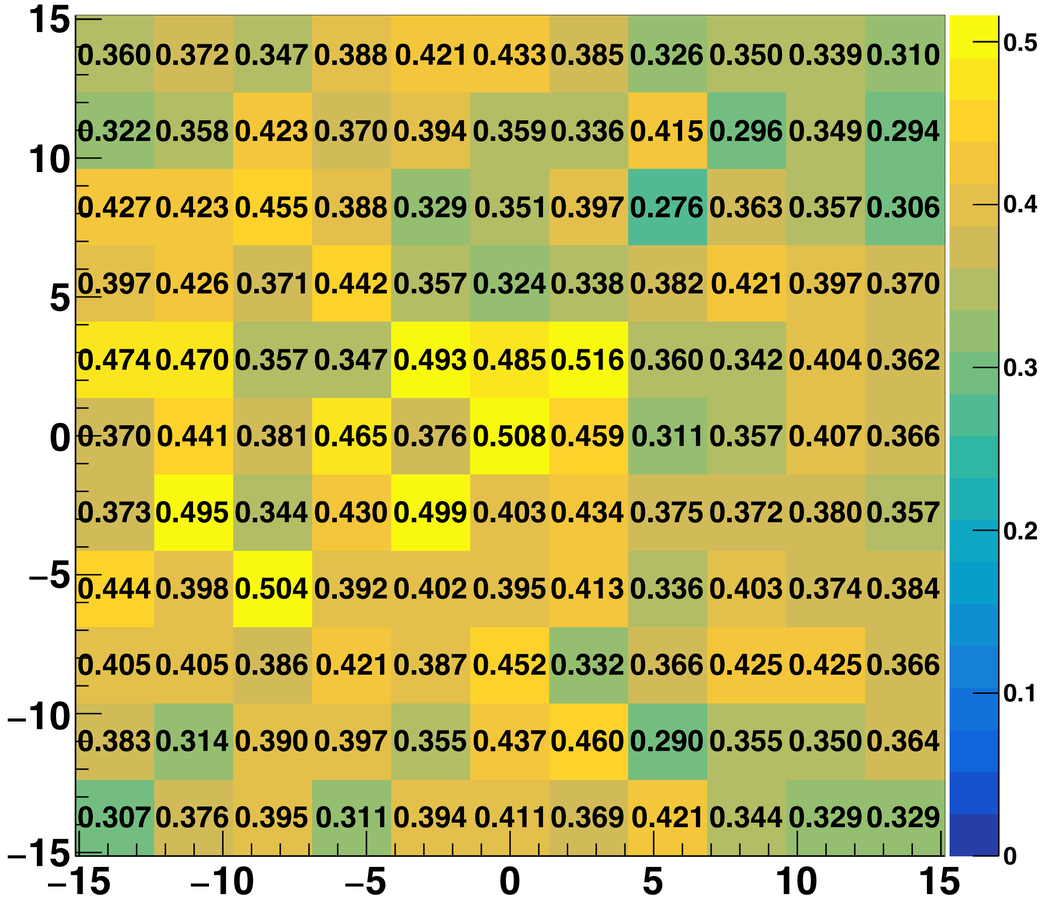
- **Geometry 4.2** PMMA  statistic 11.000 - muon 1 GeV

Winstone cone
PMT 11mm

• Geometry 4 PMMA  statistic 11.000 - muon 1 GeV

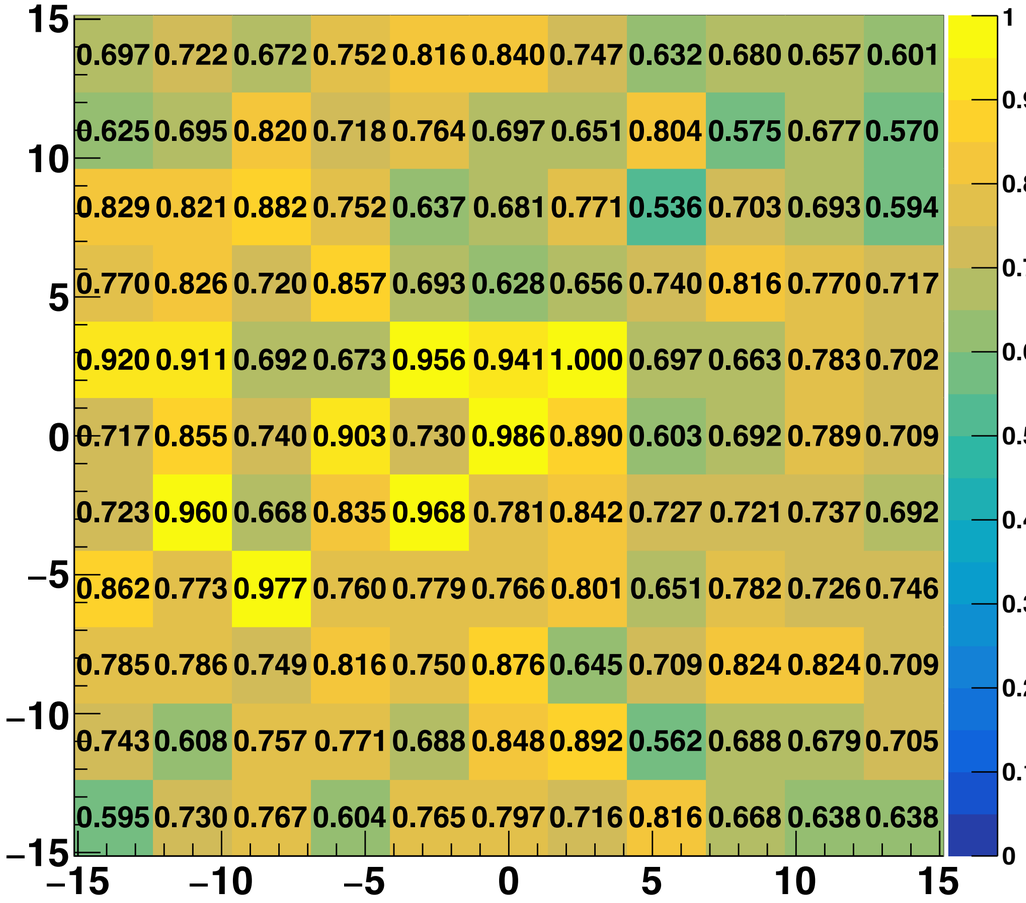
Winstone cone
PMT 11

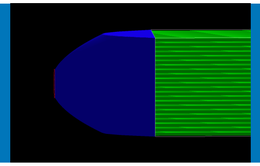
Efficiency - LG - PMMA - 2cm - base round - 11. mm



Factor non-uniformity - LG - PMMA - 2cm - base round - 11. mm

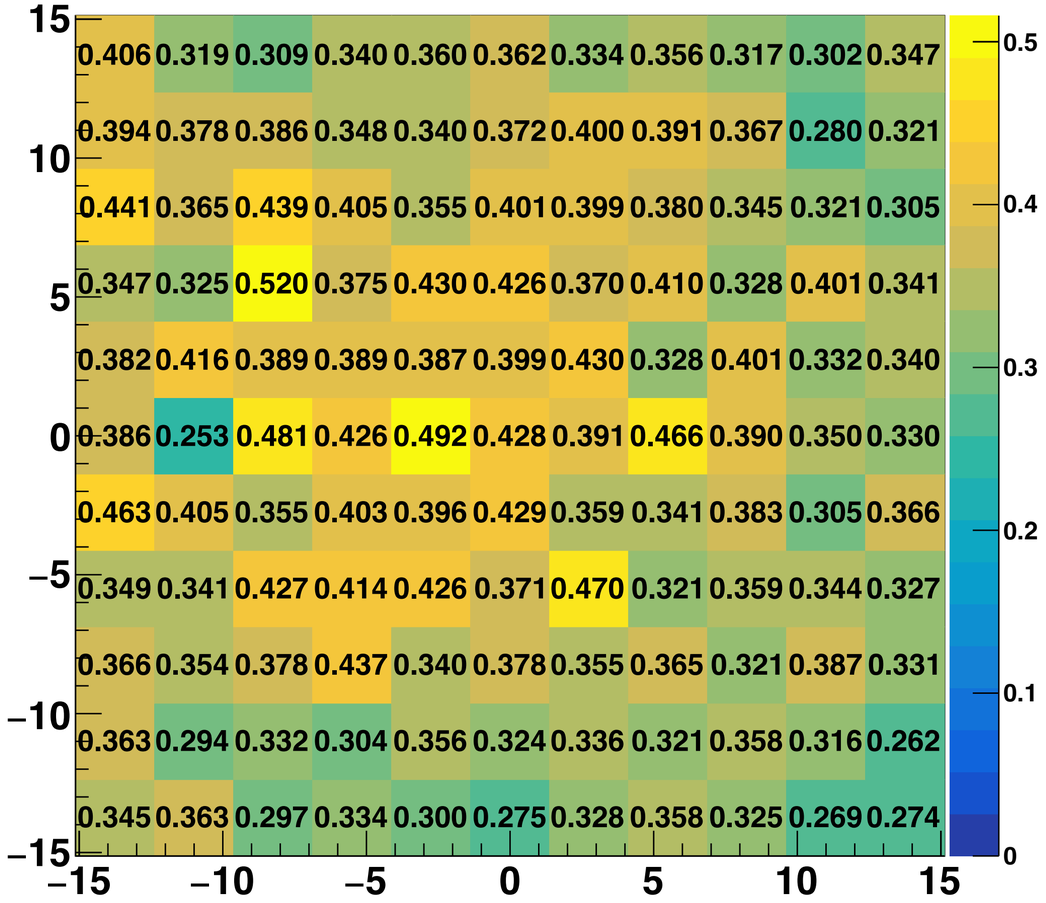
Standard deviation: 0.097 **Mean value: 0.748**



• Geometry 4 PMMA  statistic 11.000 - muon 1 GeV

Winstone cone
PMT 11

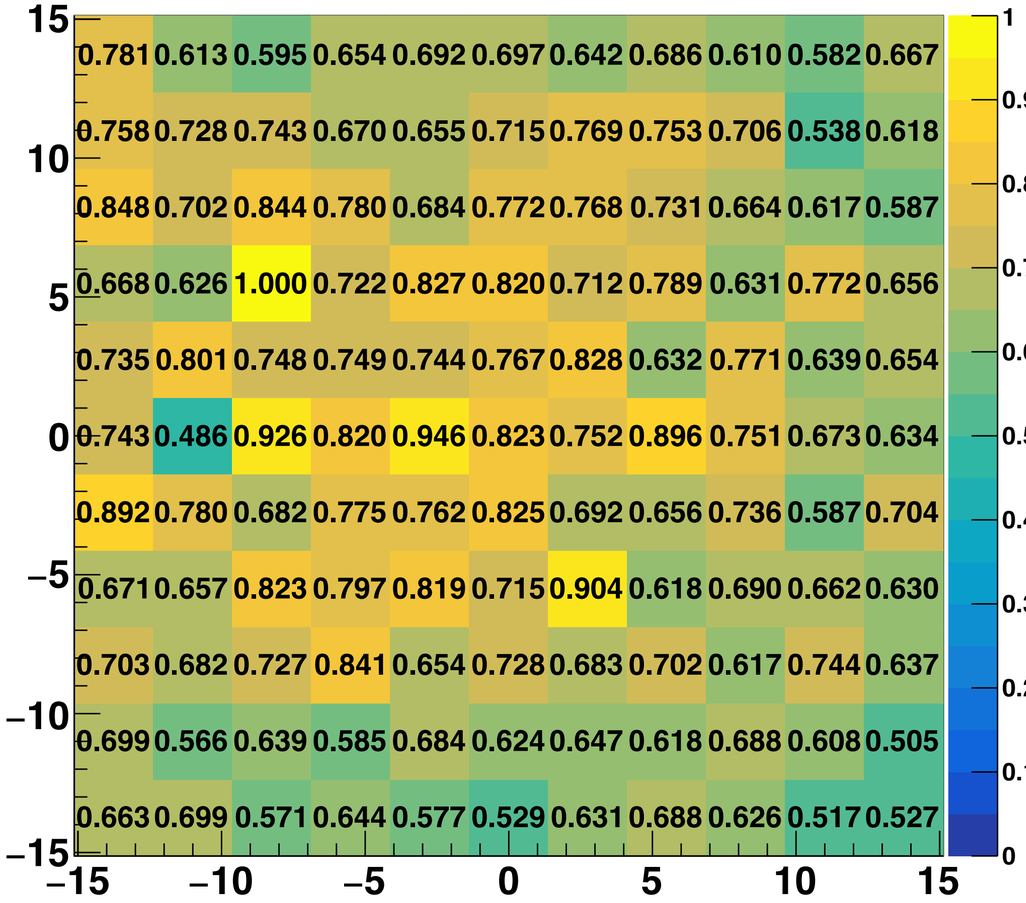
Efficiency - LG - PMMA - 3cm - base round - 11. mm

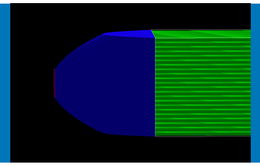


Factor non-uniformity - LG - PMMA - 3cm - base round - 11. mm

Standard deviation: 0.094

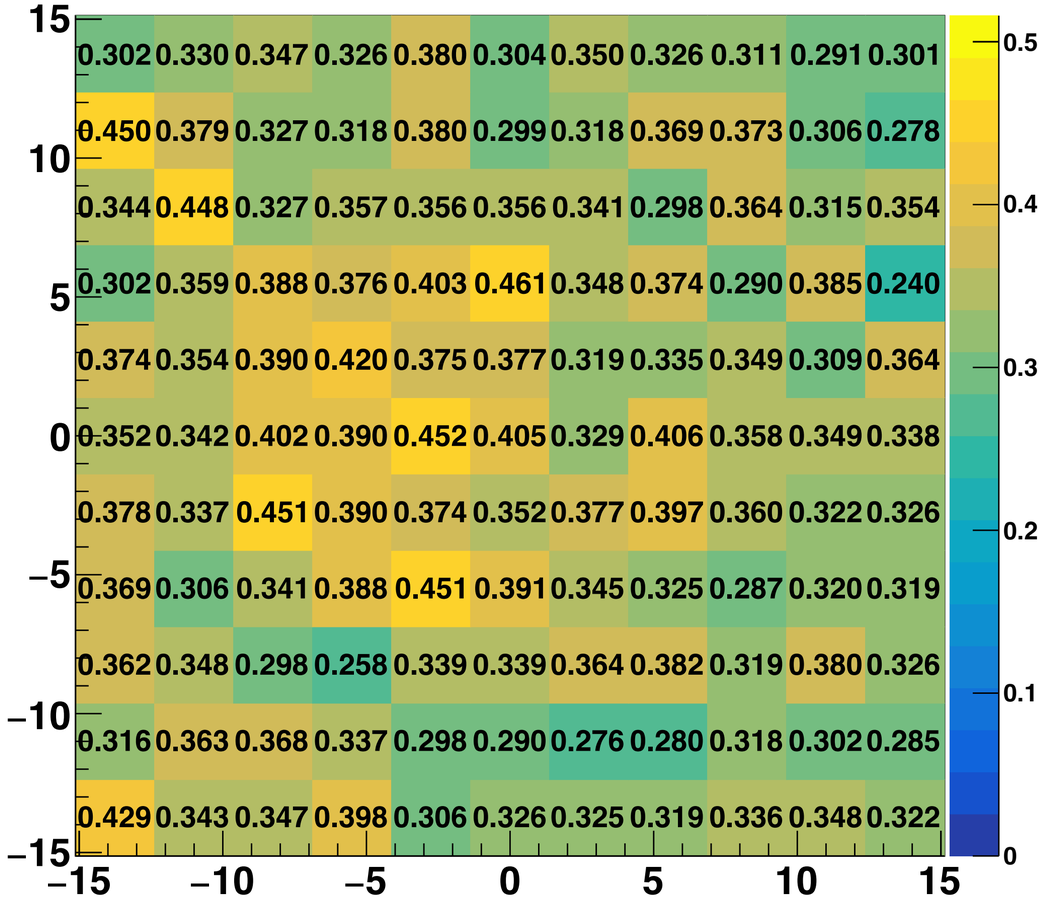
Mean value: 0.702



• Geometry 4 PMMA  statistic 11.000 - muon 1 GeV

Winstone cone
PMT 11

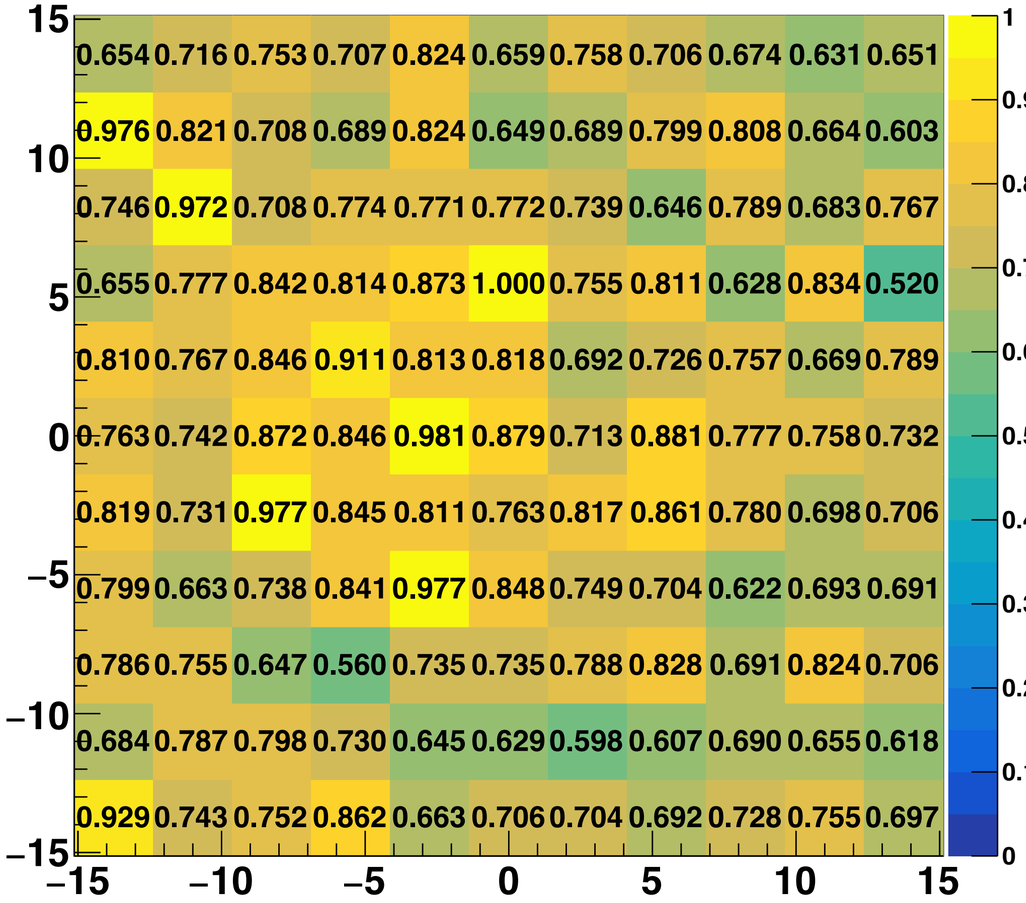
Efficiency - LG - PMMA - 4cm - base round - 11. mm

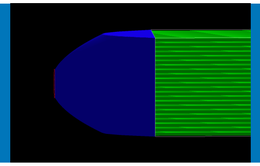


Factor non-uniformity - LG - PMMA - 4cm - base round - 11. mm

Standard deviation: 0.092

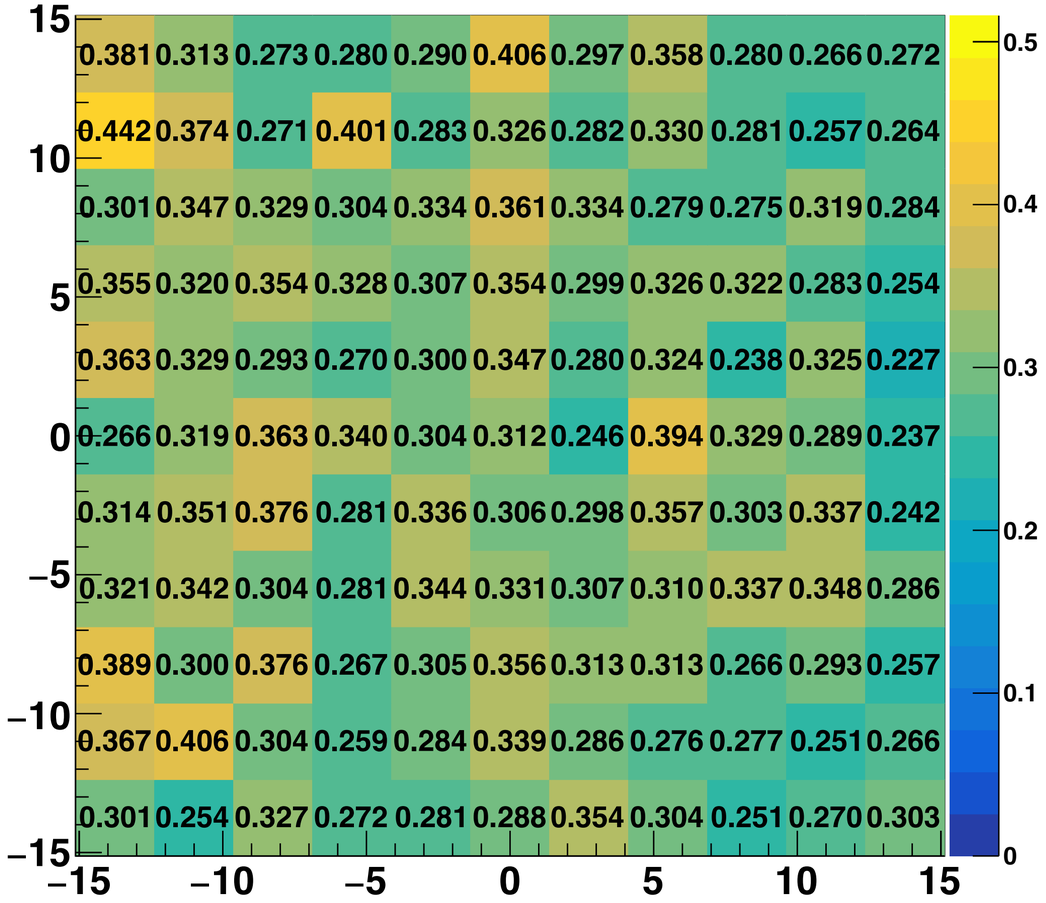
Mean value: 0.754



• Geometry 4 PMMA  statistic 11.000 - muon 1 GeV

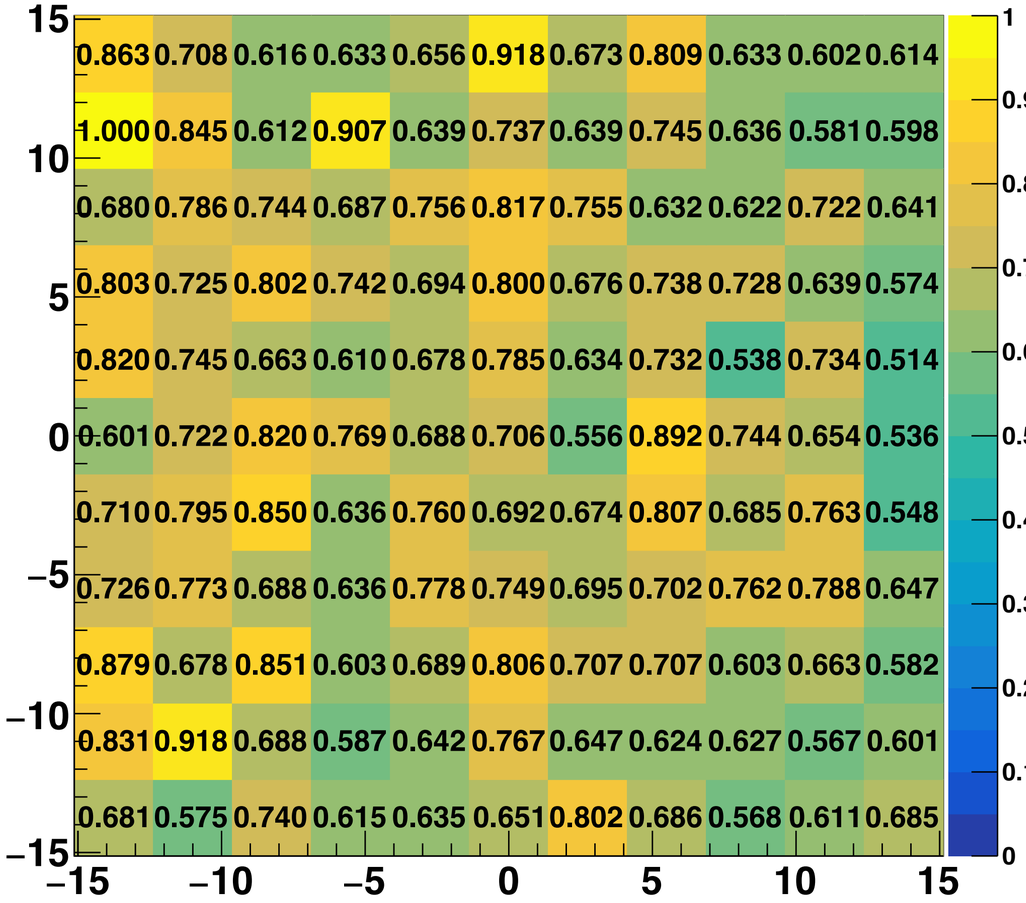
Winstone cone
PMT 11

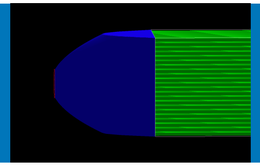
Efficiency - LG - PMMA - 5cm - base round - 11. mm



Factor non-uniformity - LG - PMMA - 5cm - base round - 11. mm

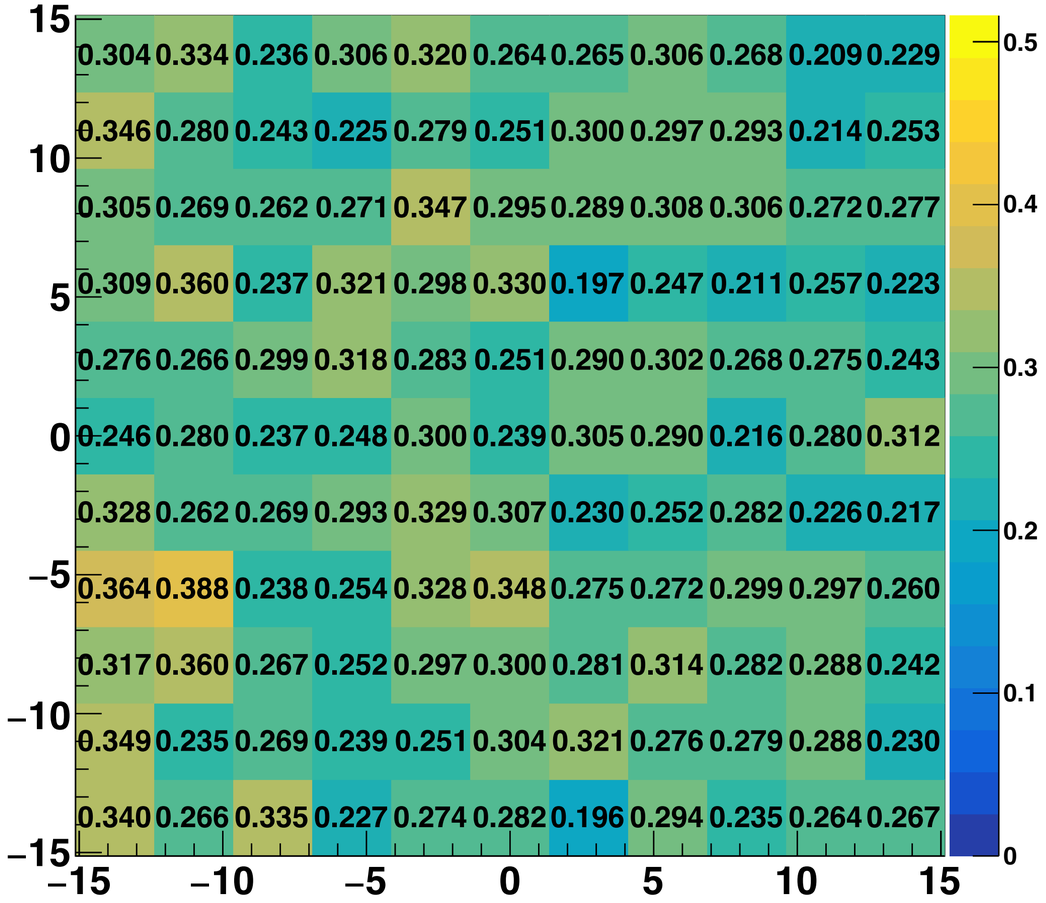
Standard deviation: 0.093 **Mean value: 0.702**



• Geometry 4 PMMA  statistic 11.000 - muon 1 GeV

Winstone cone
PMT 11

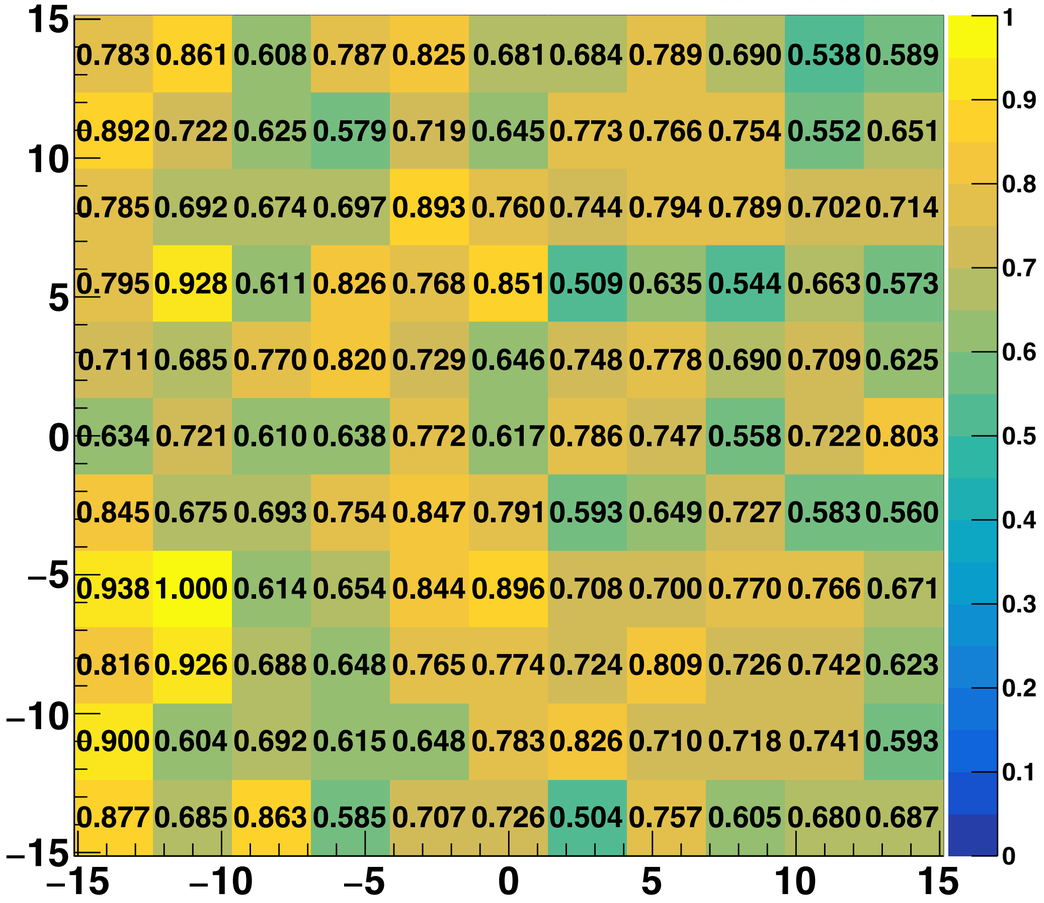
Efficiency - LG - PMMA - 6cm - base round - 11. mm

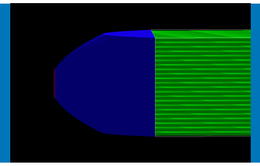


Factor non-uniformity - LG - PMMA - 6cm - base round - 11. mm

Standard deviation: 0.099

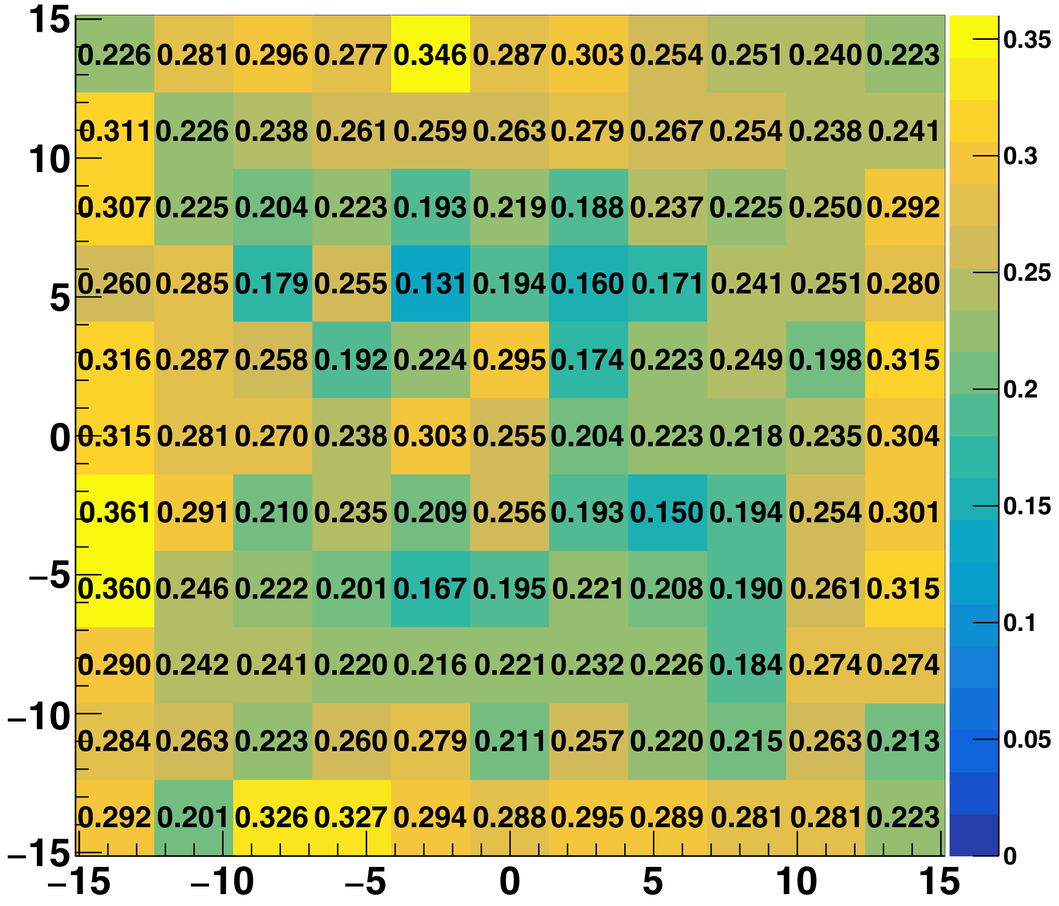
Mean value: 0.719



• Geometry 4 AIR  statistic 11.000 - muon 1 GeV

Winstone cone
PMT 11

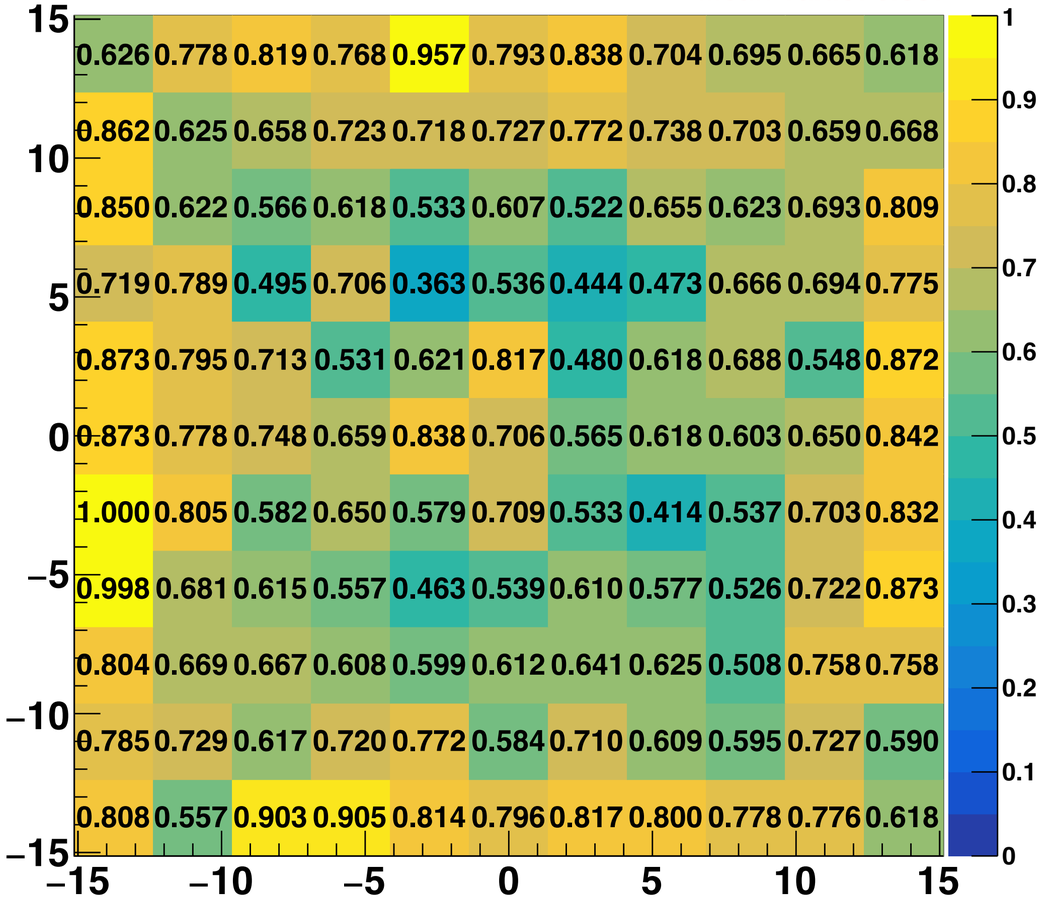
Efficiency - LG - Air - 2cm - base round - 11. mm



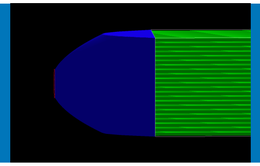
Factor non-uniformity - LG - Air - 2cm - base round - 11. mm

Standard deviation: 0.123

Mean value: 0.687



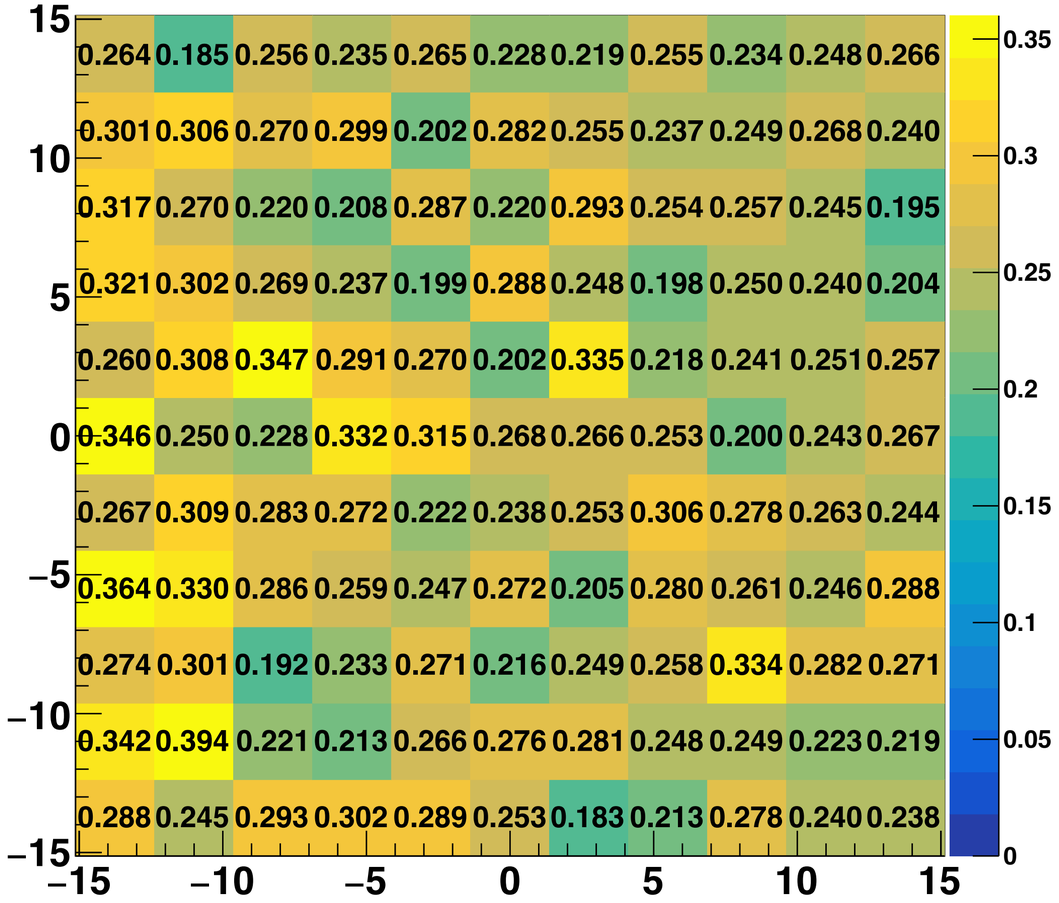
• Geometry 4 AIR



statistic 11.000 - muon 1 GeV

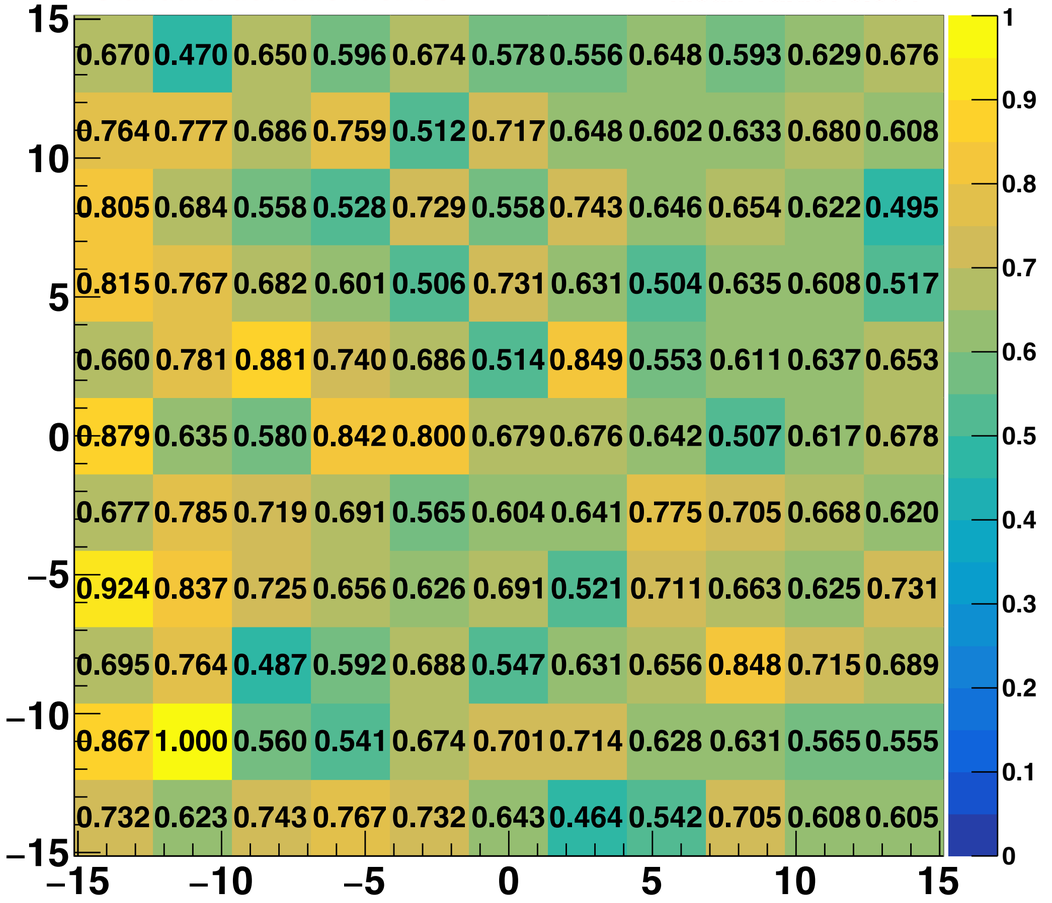
Winstone cone
PMT 11

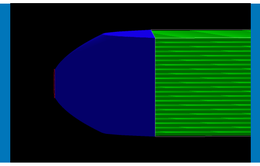
Efficiency - LG - Air - 3cm - base round - 11. mm



Factor non-uniformity - LG - Air - 3cm - base round - 11. mm

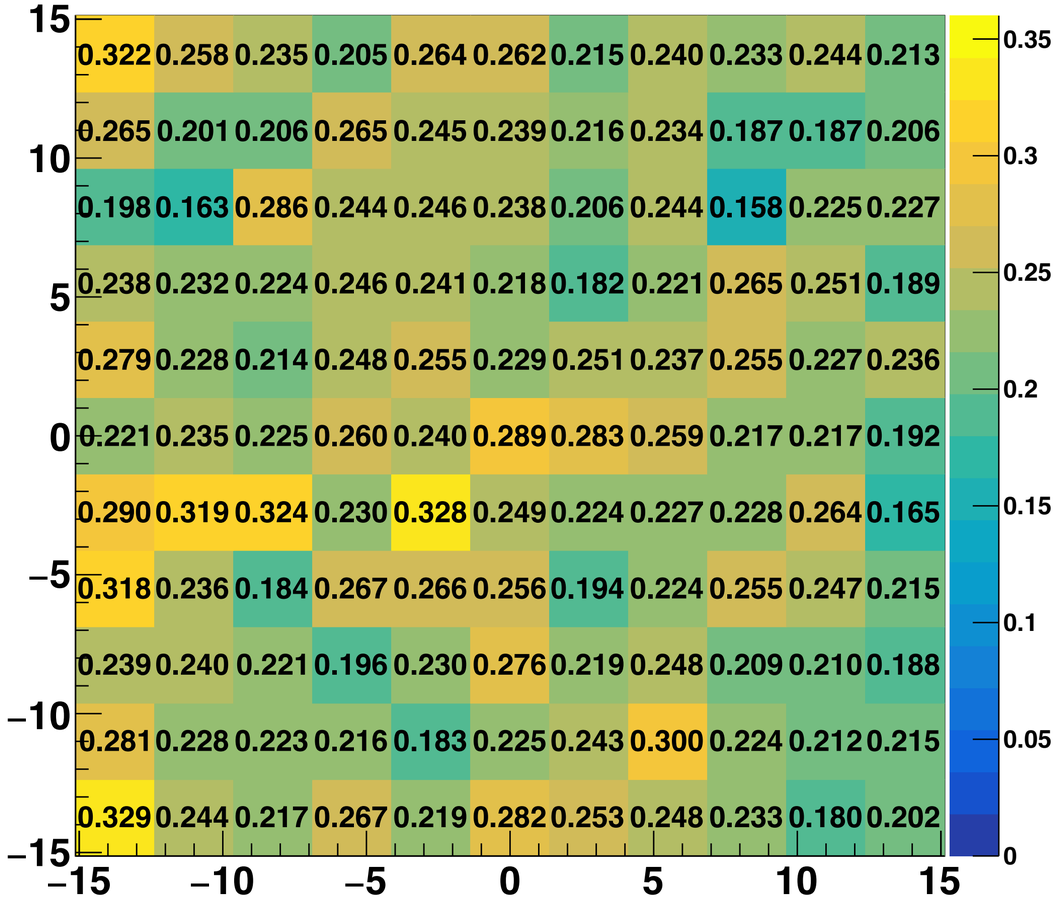
Standard deviation: 0.100 **Mean value: 0.664**



• Geometry 4 AIR  statistic 11.000 - muon 1 GeV

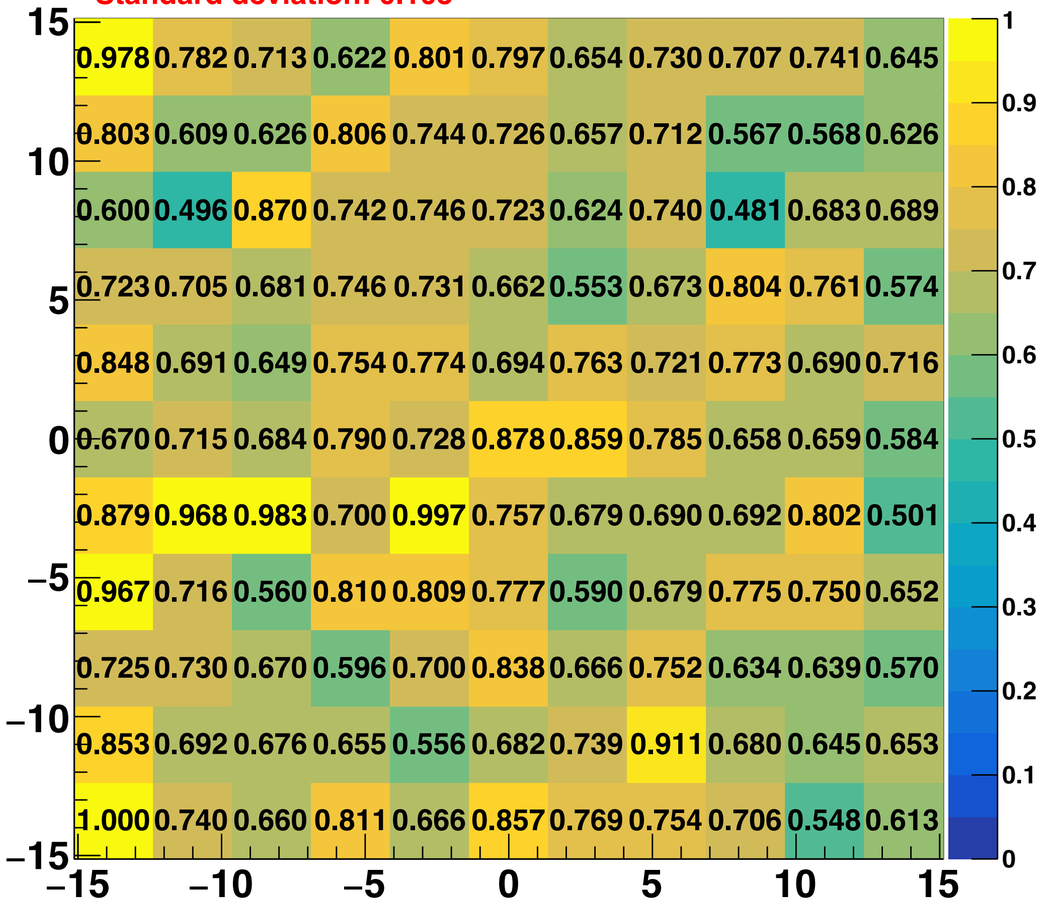
Winstone cone
PMT 11

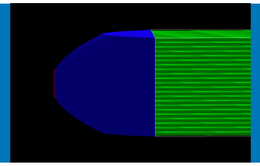
Efficiency - LG - Air - 4cm - base round - 11. mm



Factor non-uniformity - LG - Air - 4cm - base round - 11. mm

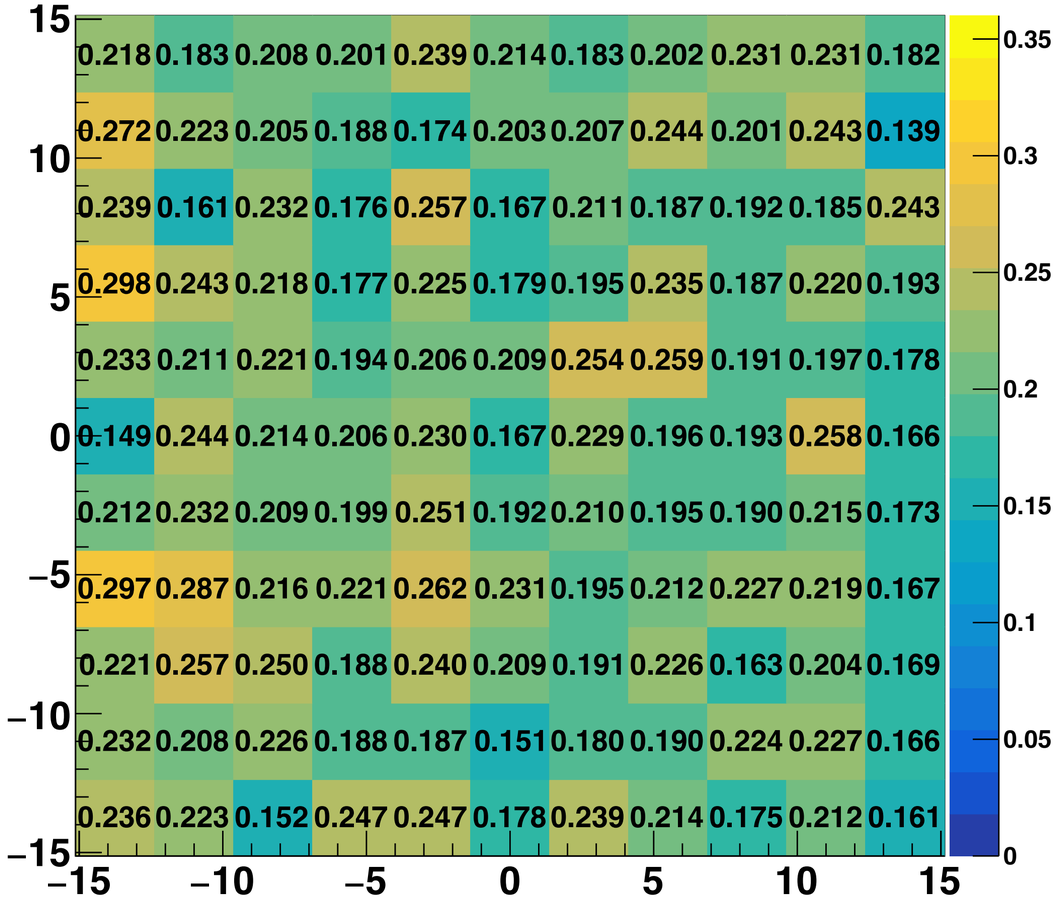
Standard deviation: 0.103 Mean value: 0.718



• Geometry 4 AIR  statistic 11.000 - muon 1 GeV

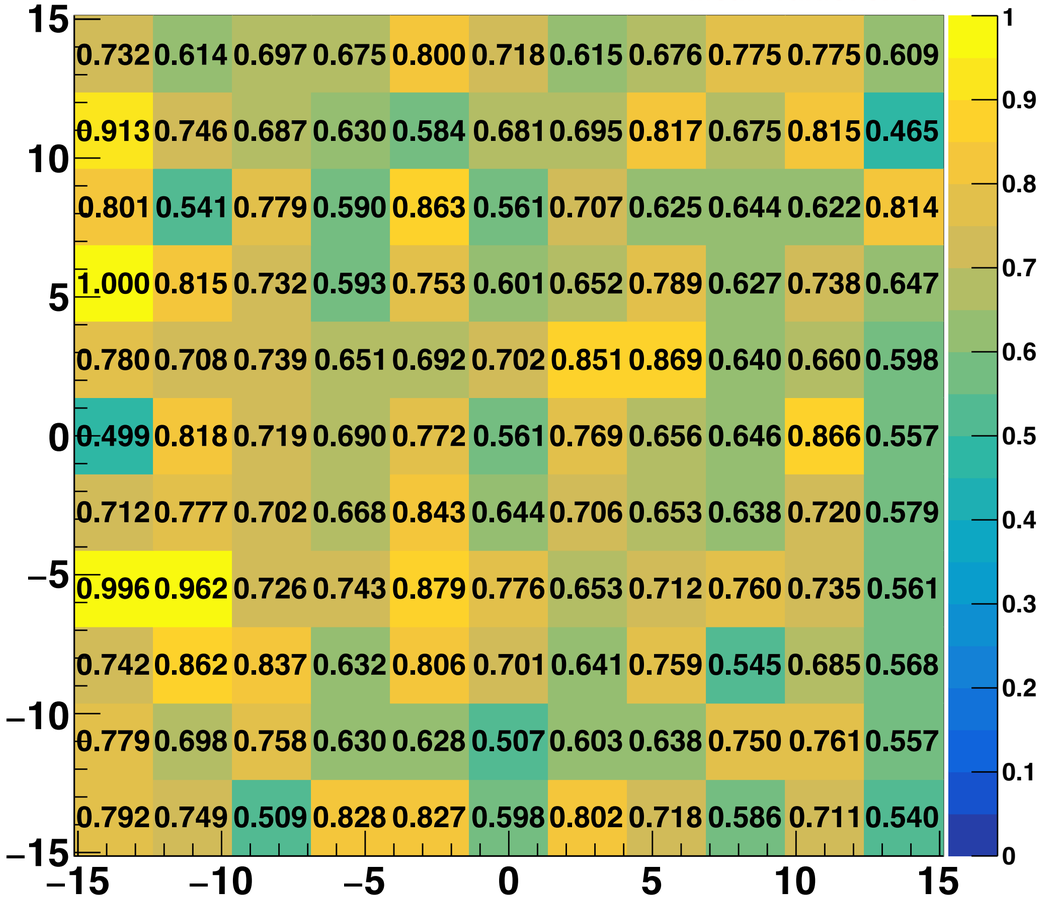
Winstone cone
PMT 11

Efficiency - LG - Air - 5cm - base round - 11. mm

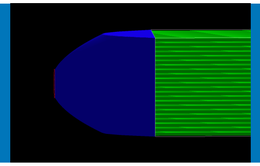


Factor non-uniformity - LG - Air - 5cm - base round - 11. mm

Standard deviation: 0.104 **Mean value: 0.704**



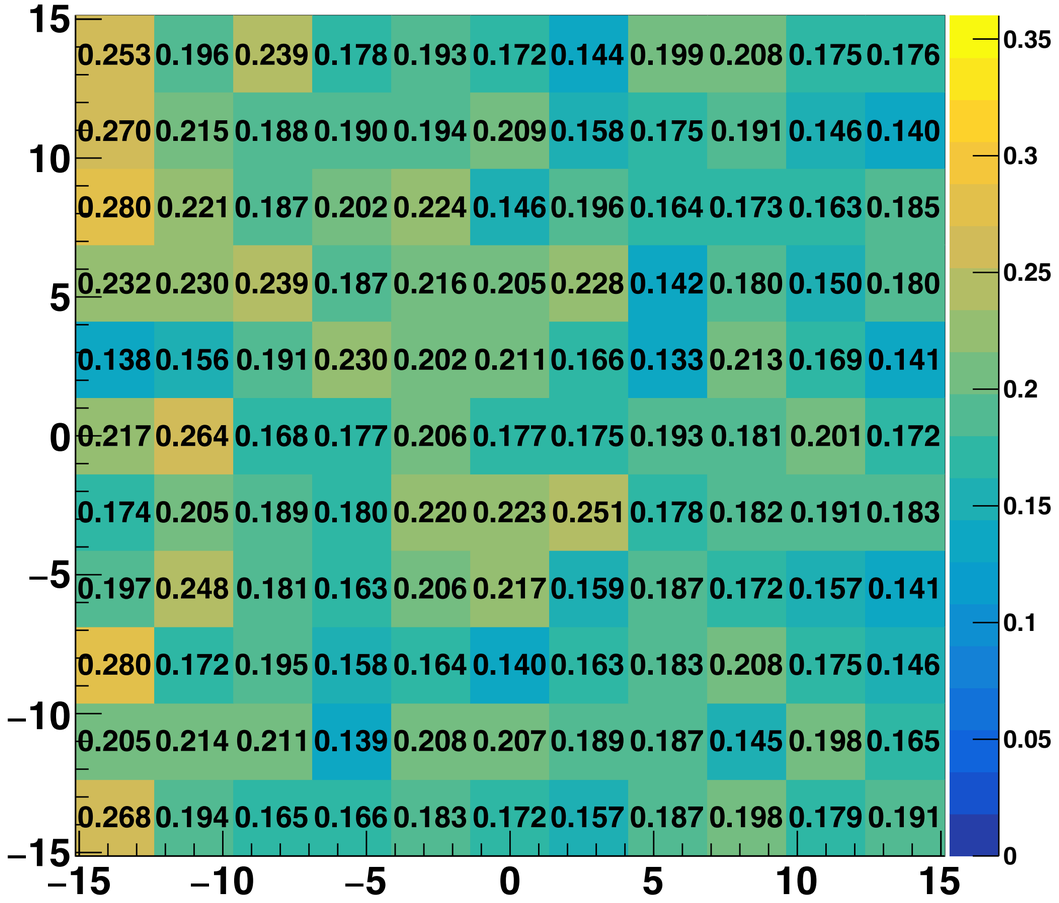
• Geometry 4 AIR



statistic 11.000 - muon 1 GeV

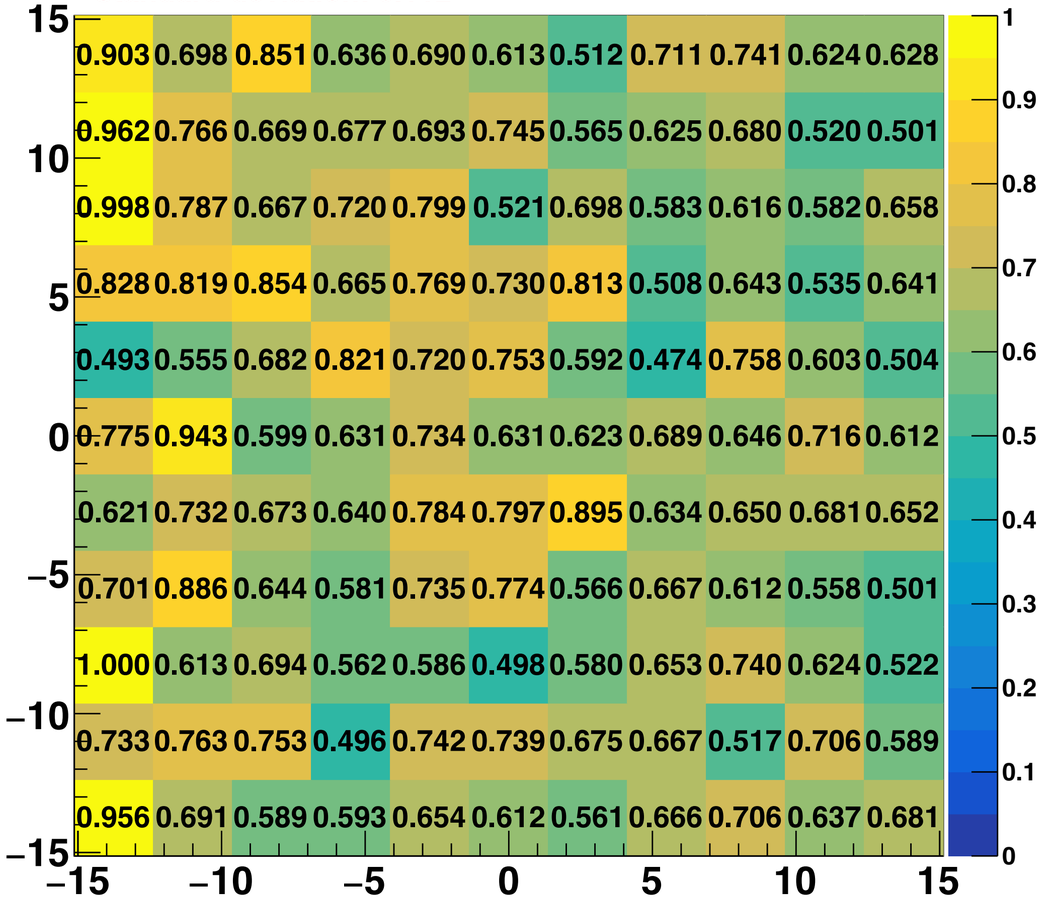
Winstone cone
PMT 11

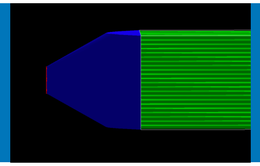
Efficiency - LG - Air - 6cm - base round - 11. mm



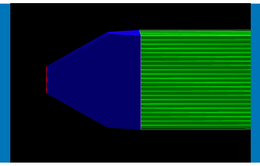
Factor non-uniformity - LG - Air - 6cm - base round - 11. mm

Standard deviation: 0.112 **Mean value: 0.676**



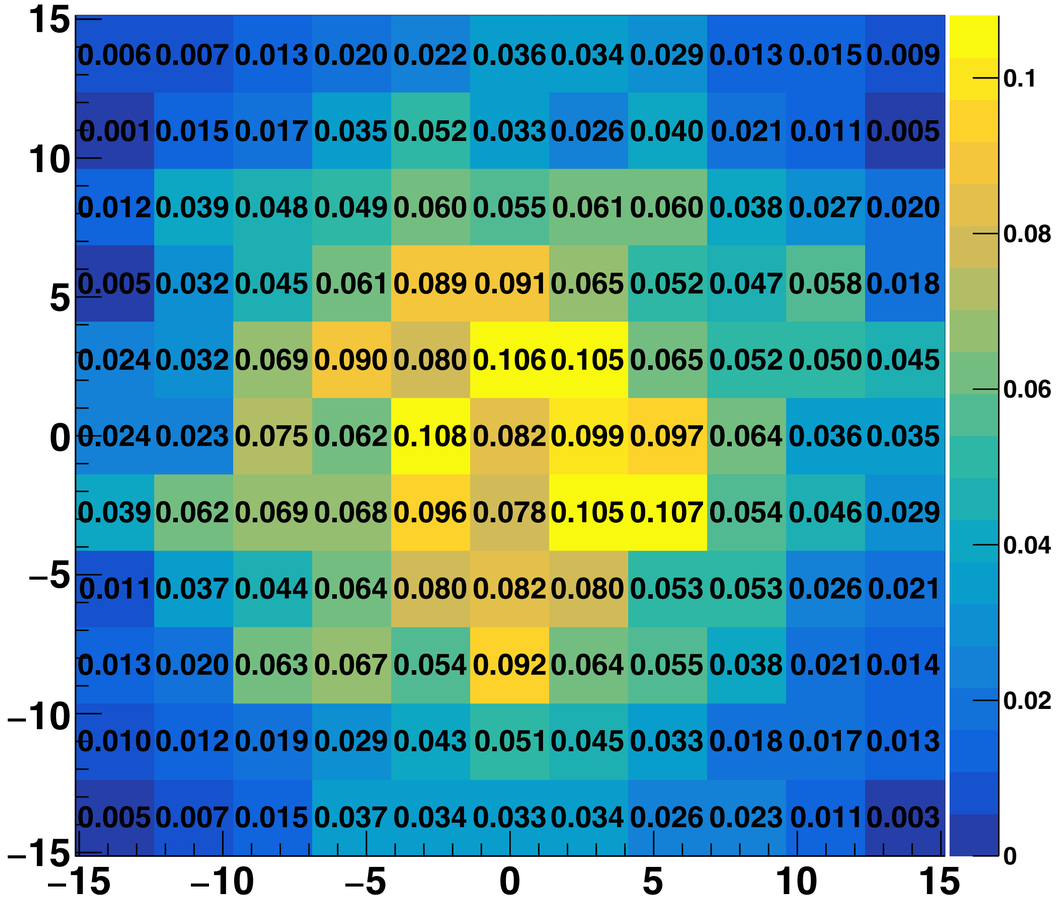
- **Geometry 5** PMMA  statistic 11.000 - muon 1 GeV

FISH TAIL
PMT 4.5

• Geometry 5 PMMA  statistic 11.000 - muon 1 GeV

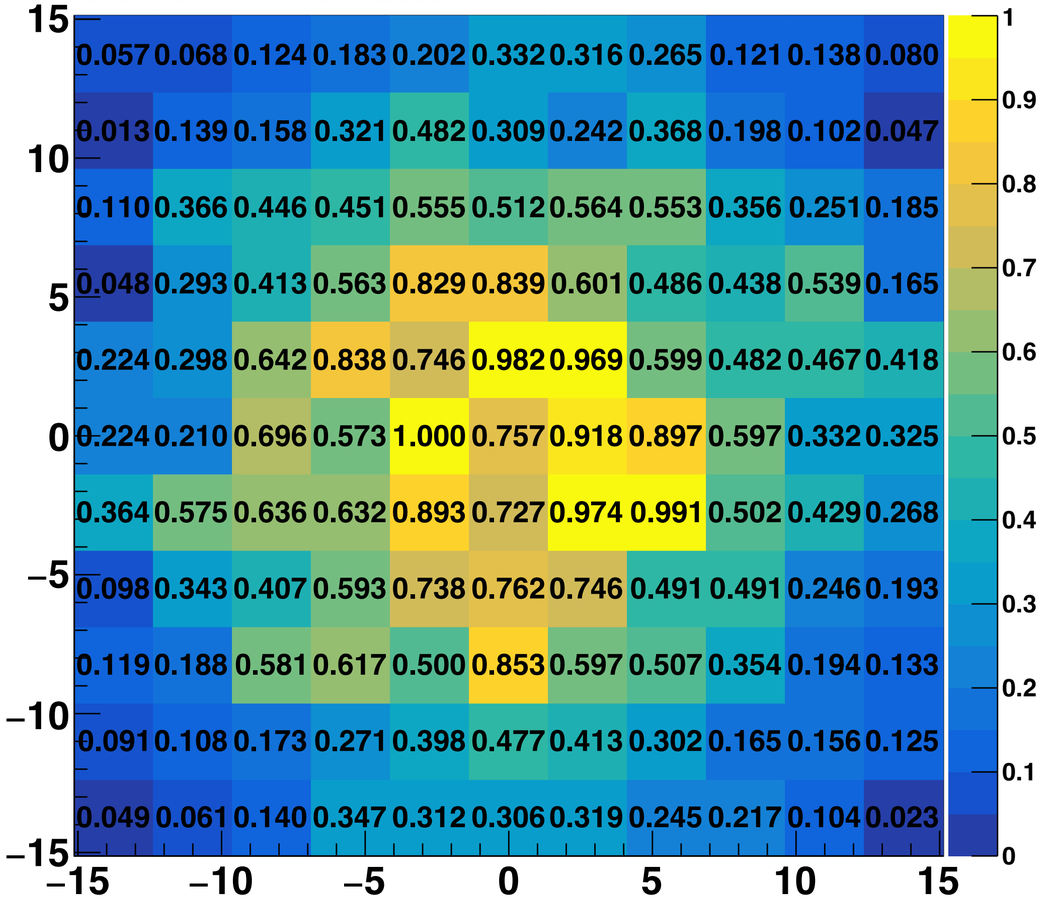
FISH TAIL
PMT 4.5

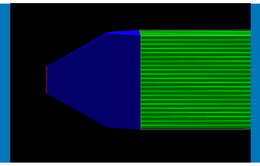
Efficiency - LG - PMMA - 2cm - base round - 4.5 mm



Factor non-uniformity - LG - PMMA - 2cm - base round - 4.5 mm

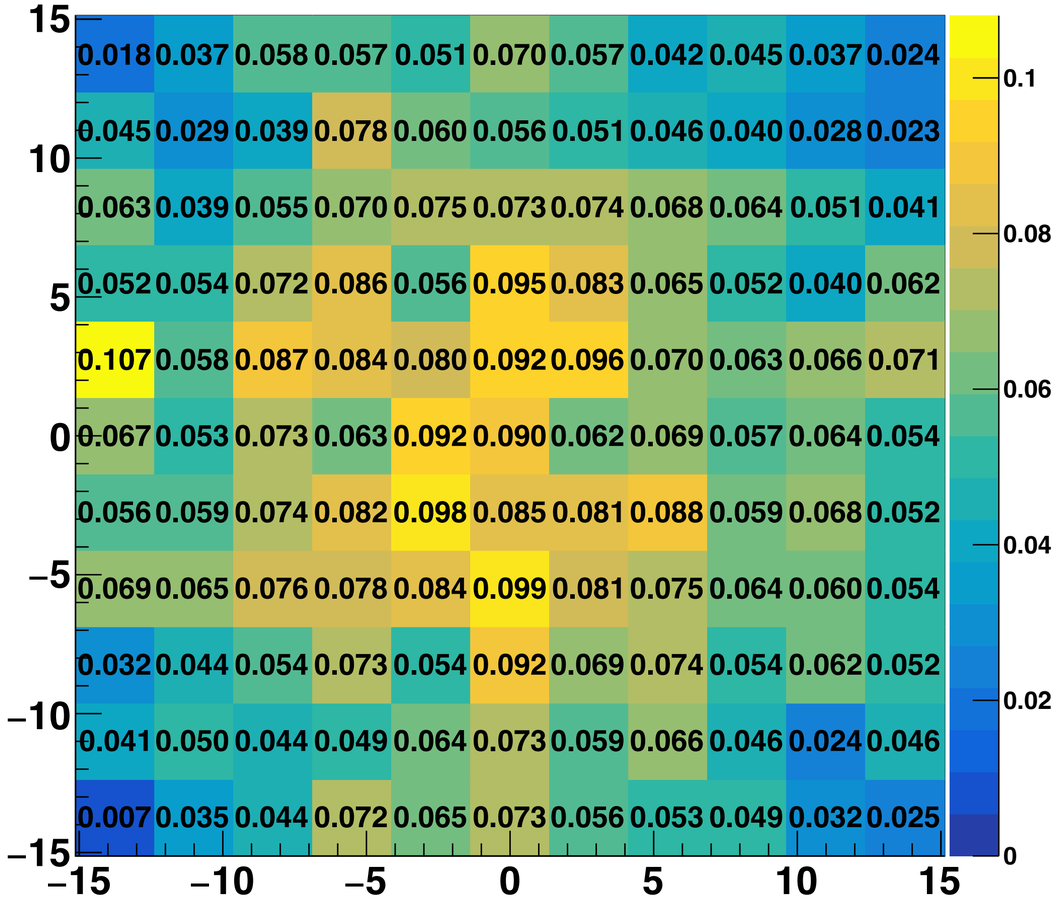
Standard deviation: 0.256 **Mean value: 0.401**



• Geometry 5 PMMA  statistic 11.000 - muon 1 GeV

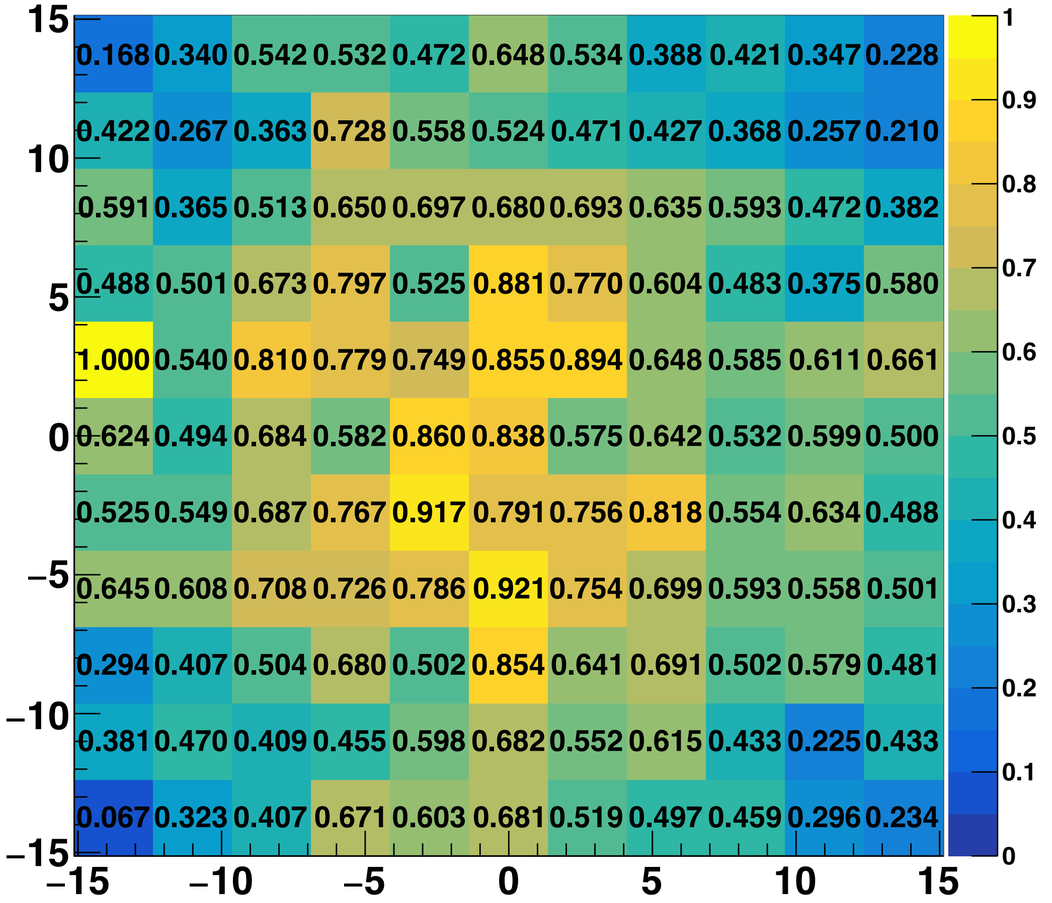
FISH TAIL
PMT 4.5

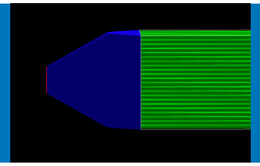
Efficiency - LG - PMMA - 3cm - base round - 4.5 mm



Factor non-uniformity - LG - PMMA - 3cm - base round - 4.5 mm

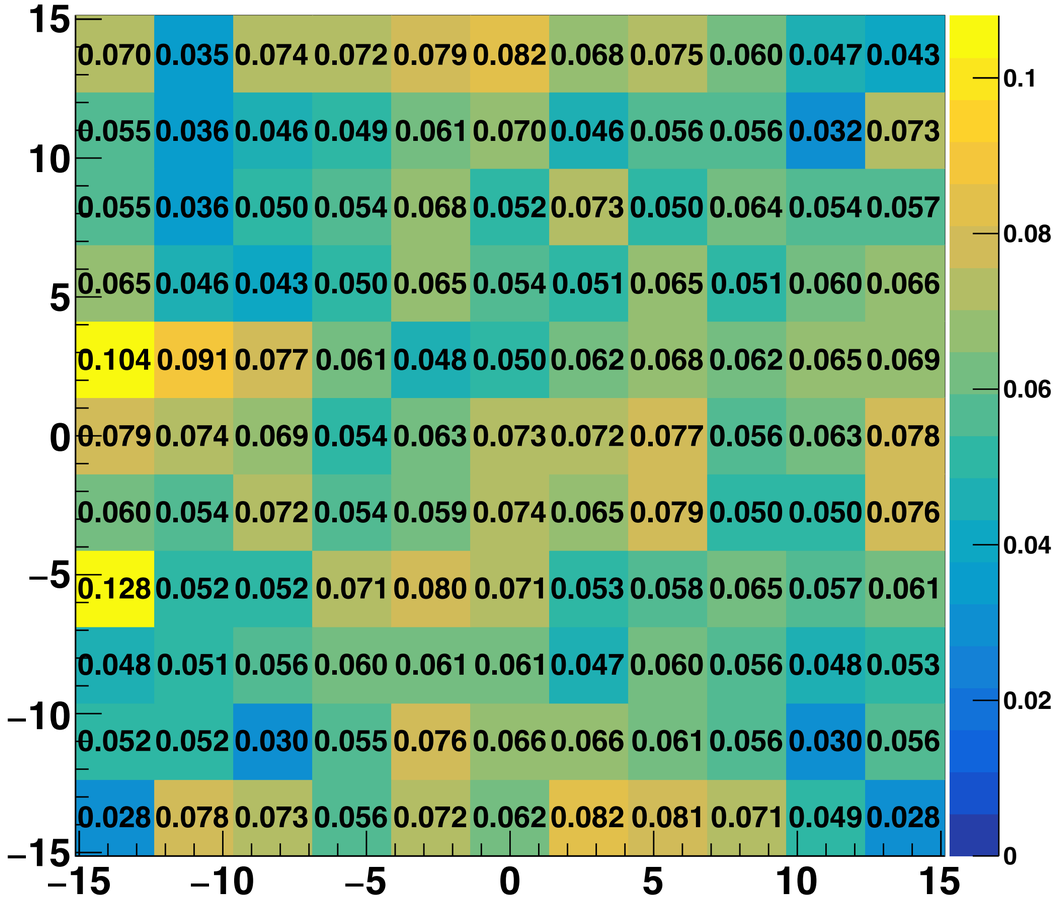
Standard deviation: 0.175 **Mean value: 0.565**



• Geometry 5 PMMA  statistic 11.000 - muon 1 GeV

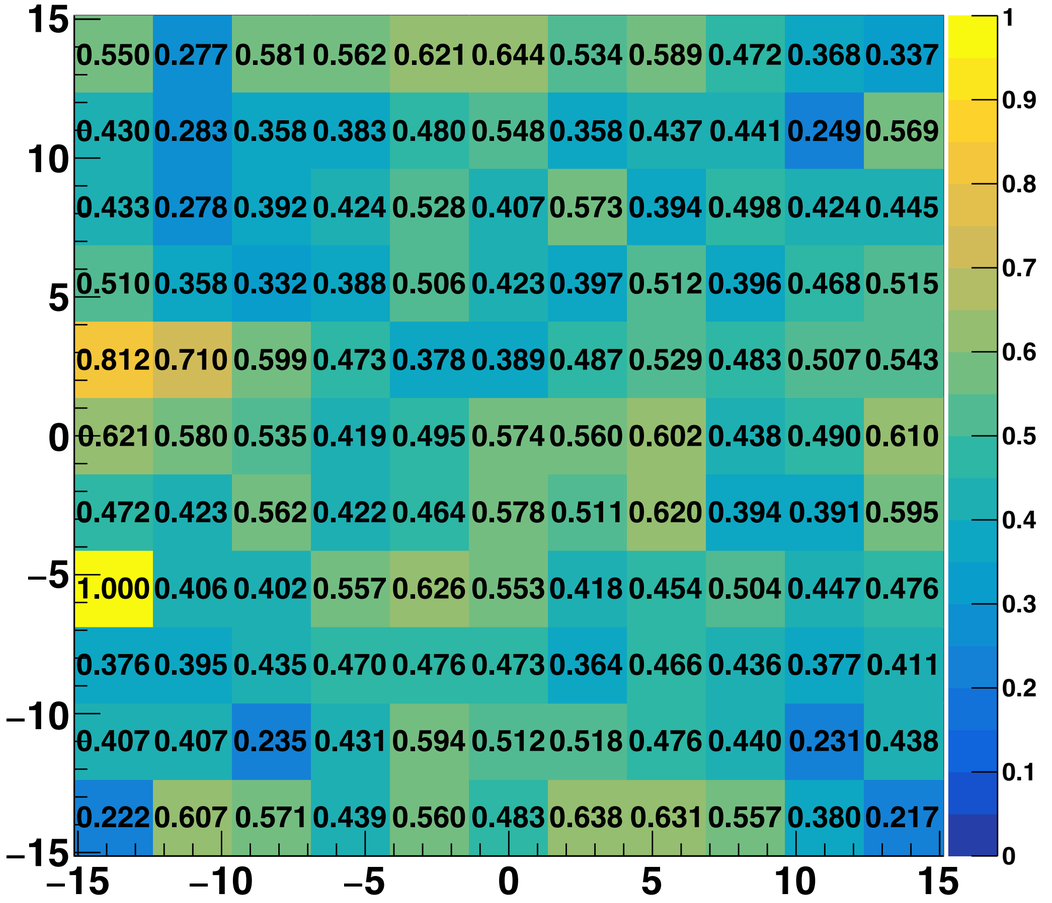
FISH TAIL
PMT 4.5

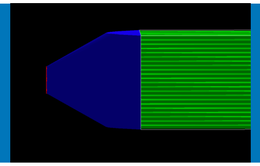
Efficiency - LG - PMMA - 4cm - base round - 4.5 mm



Factor non-uniformity - LG - PMMA - 4cm - base round - 4.5 mm

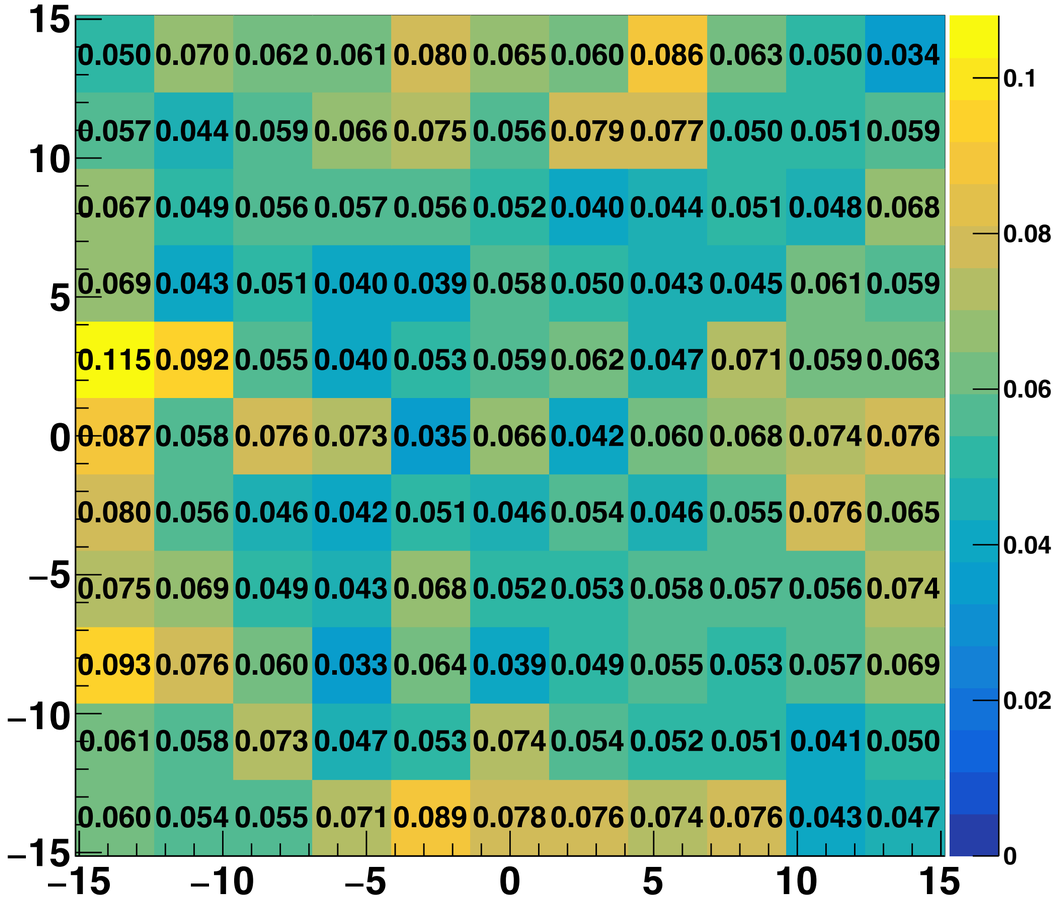
Standard deviation: 0.114 **Mean value: 0.475**



• Geometry 5 PMMA  statistic 11.000 - muon 1 GeV

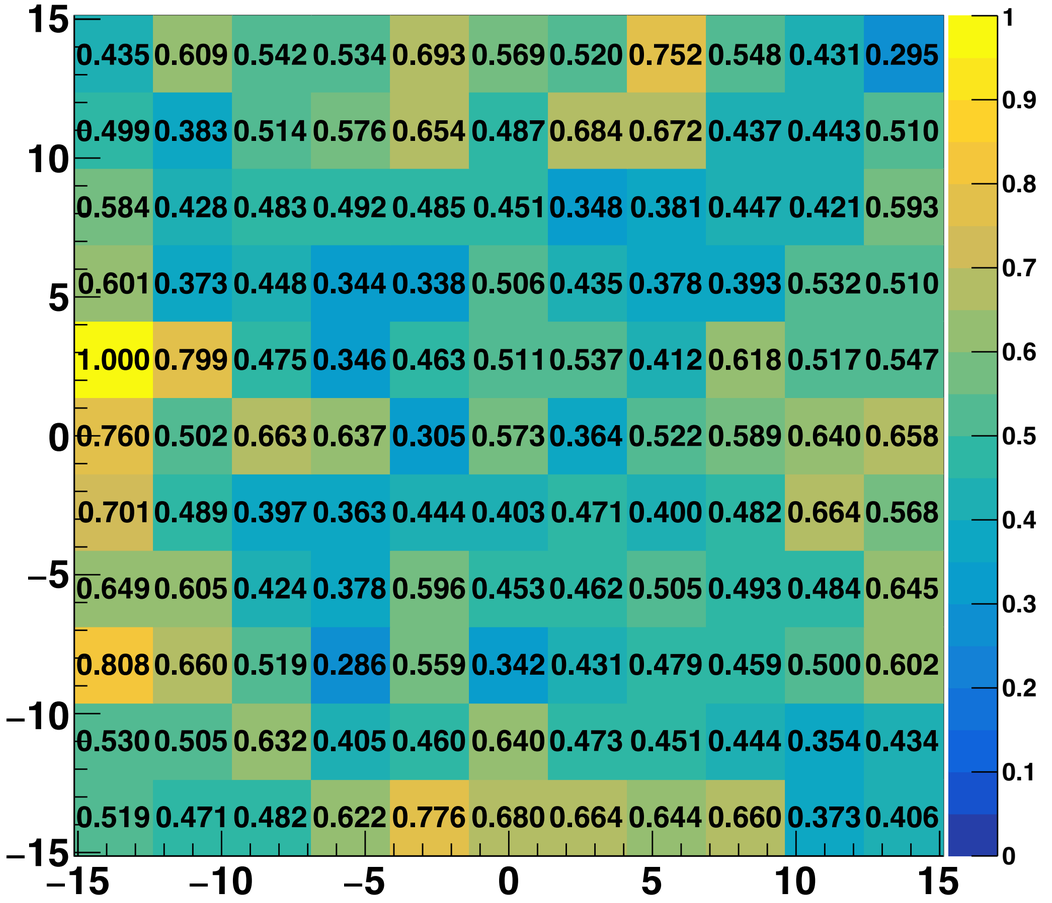
FISH TAIL
PMT 4.5

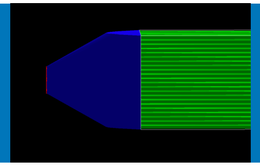
Efficiency - LG - PMMA - 5cm - base round - 4.5 mm



Factor non-uniformity - LG - PMMA - 5cm - base round - 4.5 mm

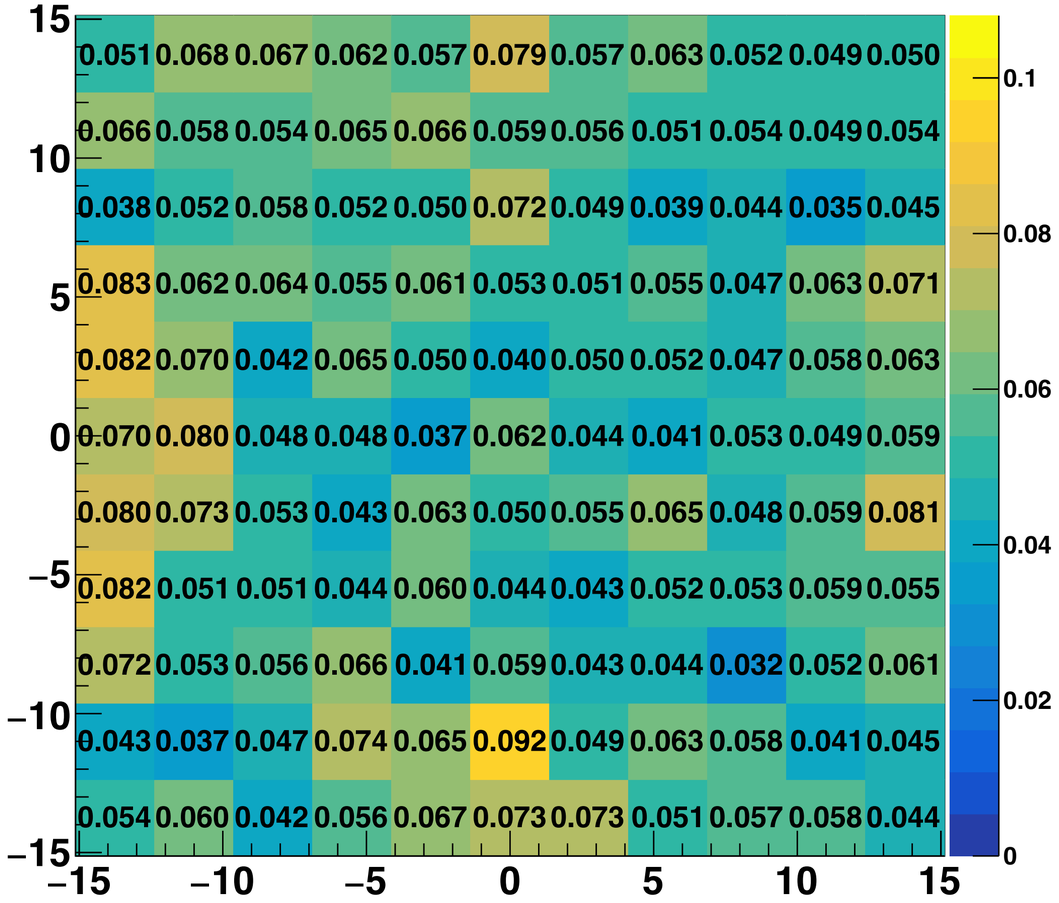
Standard deviation: 0.121 **Mean value: 0.517**



• Geometry 5 PMMA  statistic 11.000 - muon 1 GeV

FISH TAIL
PMT 4.5

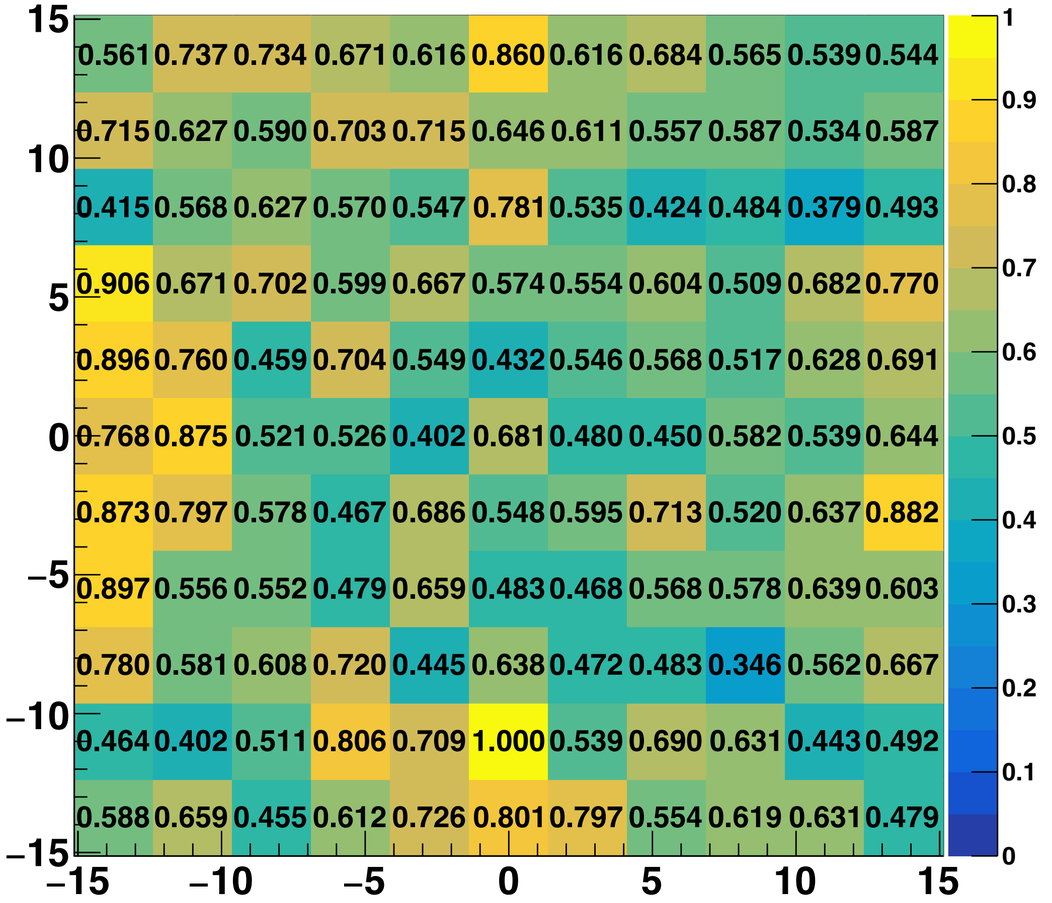
Efficiency - LG - PMMA - 6cm - base round - 4.5 mm



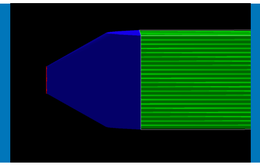
Factor non-uniformity - LG - PMMA - 6cm - base round - 4.5 mm

Standard deviation: 0.126

Mean value: 0.611



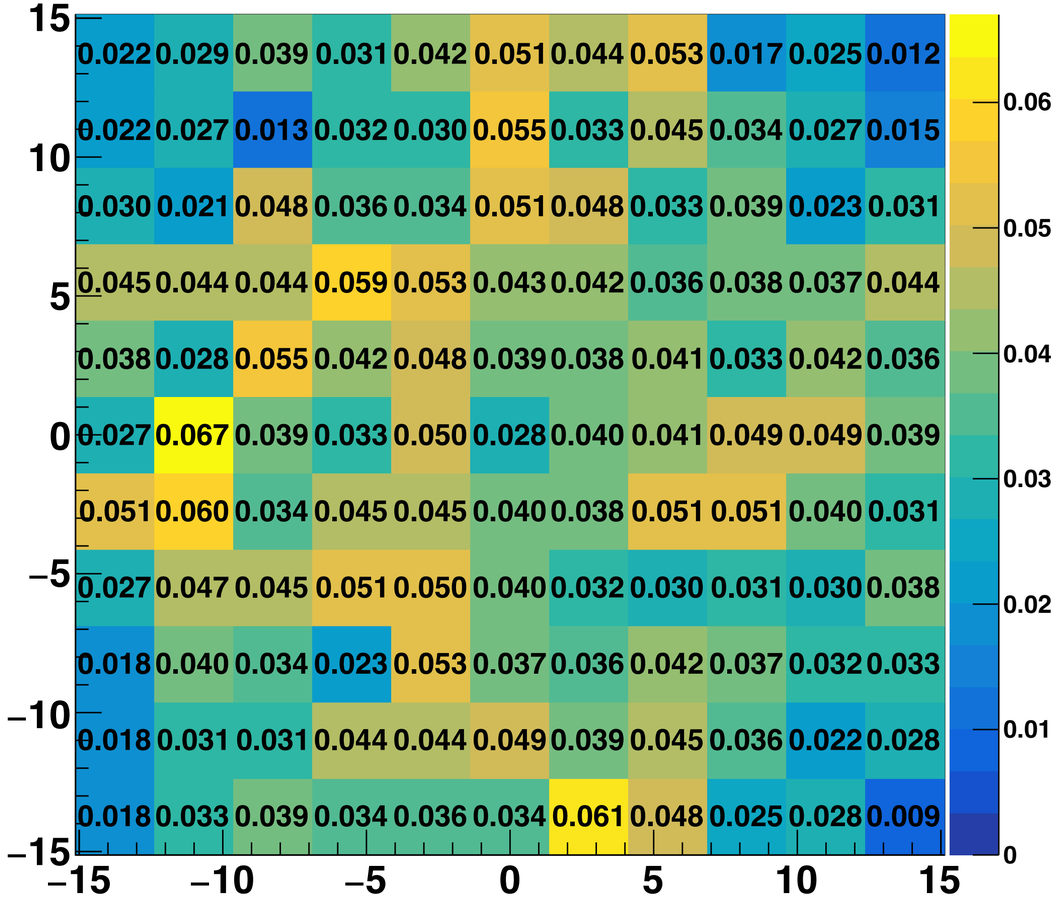
• Geometry 5 AIR



statistic 11.000 - muon 1 GeV

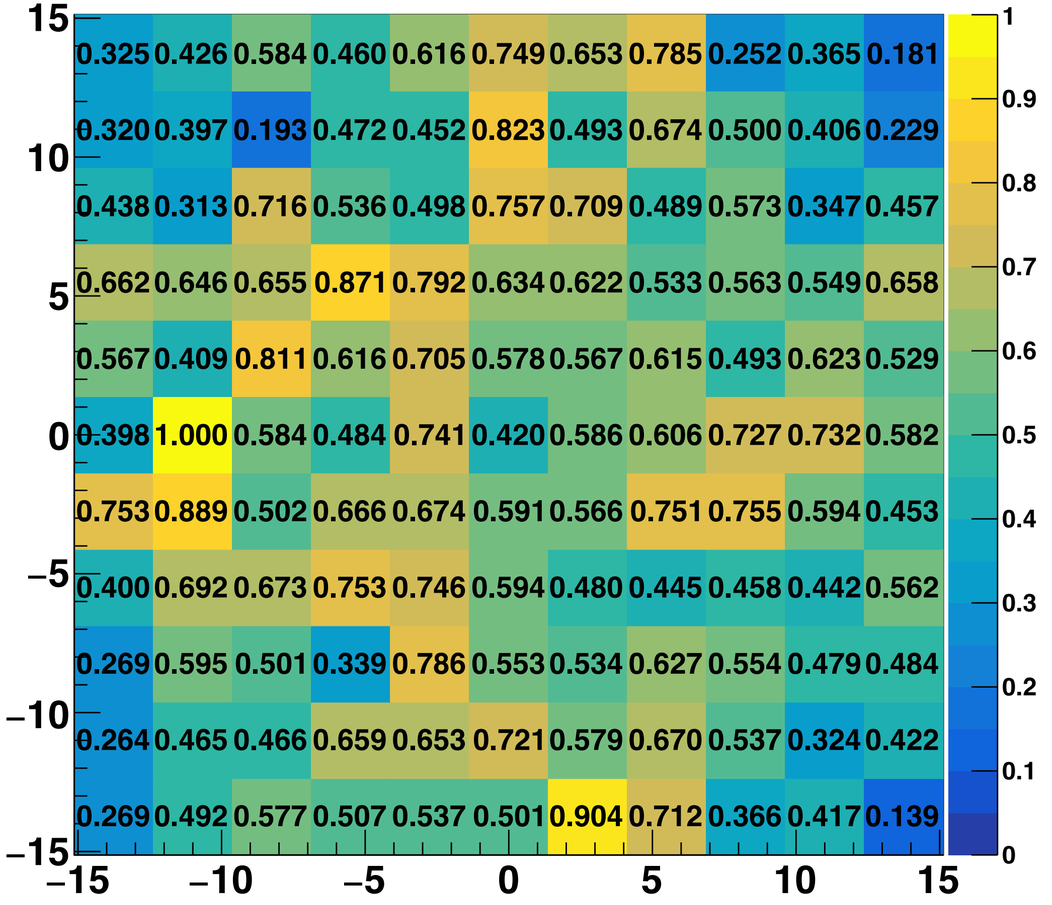
FISH TAIL
PMT 4.5

Efficiency - LG - Air - 2cm - base round - 4.5 mm

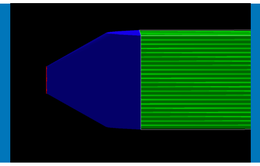


Factor non-uniformity - LG - Air - 2cm - base round - 4.5 mm

Standard deviation: 0.161 **Mean value: 0.554**



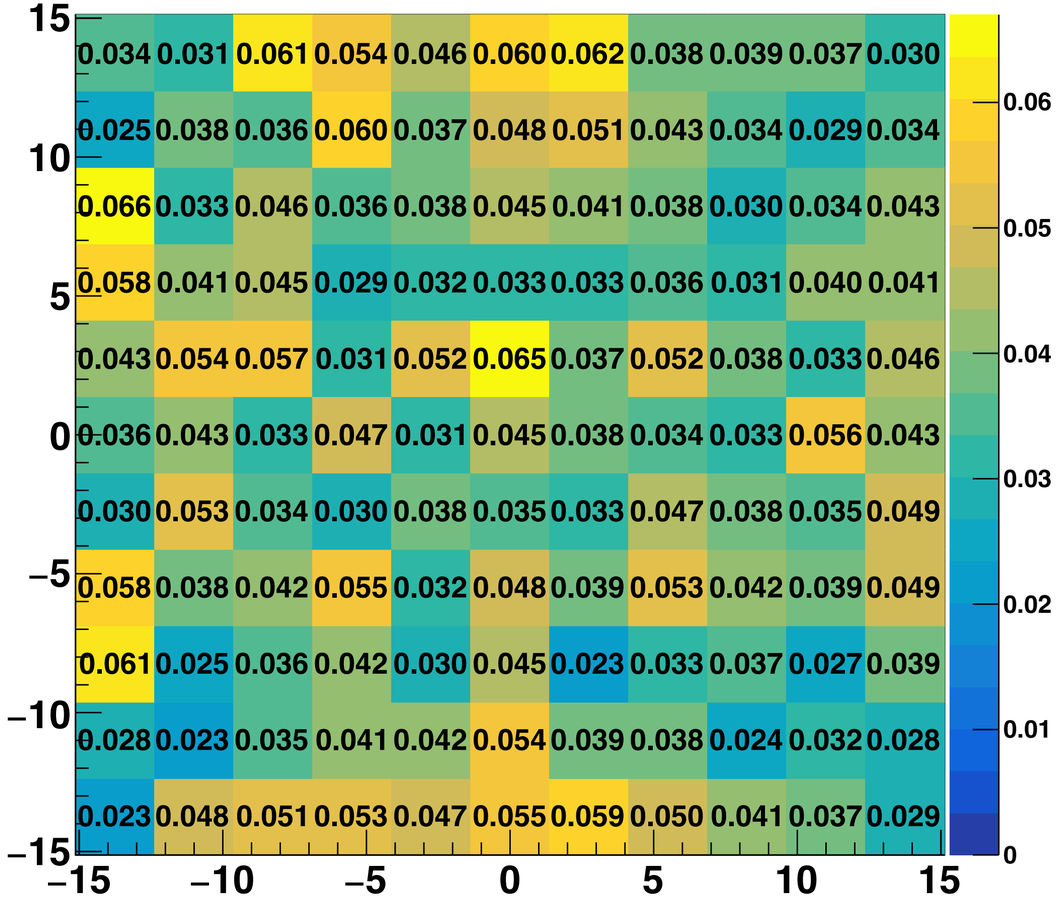
• Geometry 5 AIR



statistic 11.000 - muon 1 GeV

FISH TAIL
PMT 4.5

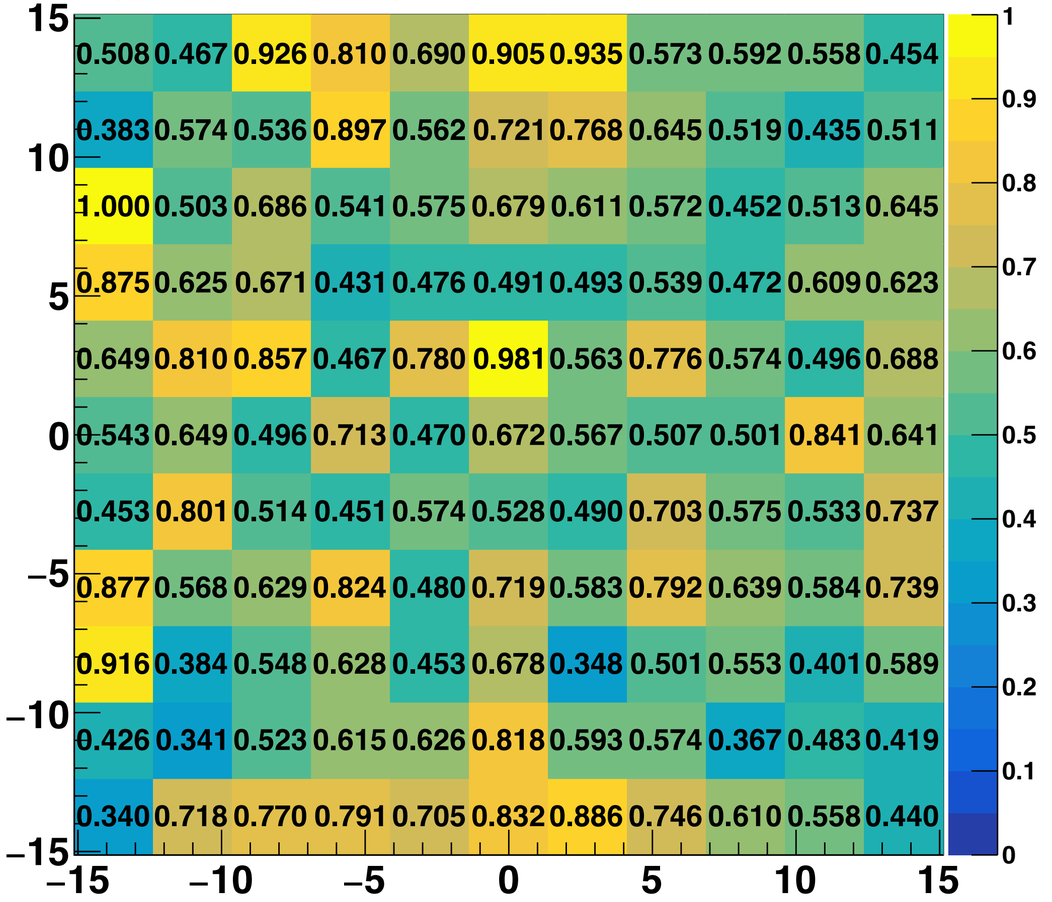
Efficiency - LG - Air - 3cm - base round - 4.5 mm



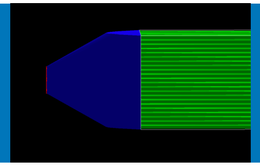
Factor non-uniformity - LG - Air - 3cm - base round - 4.5 mm

Standard deviation: 0.151

Mean value: 0.614



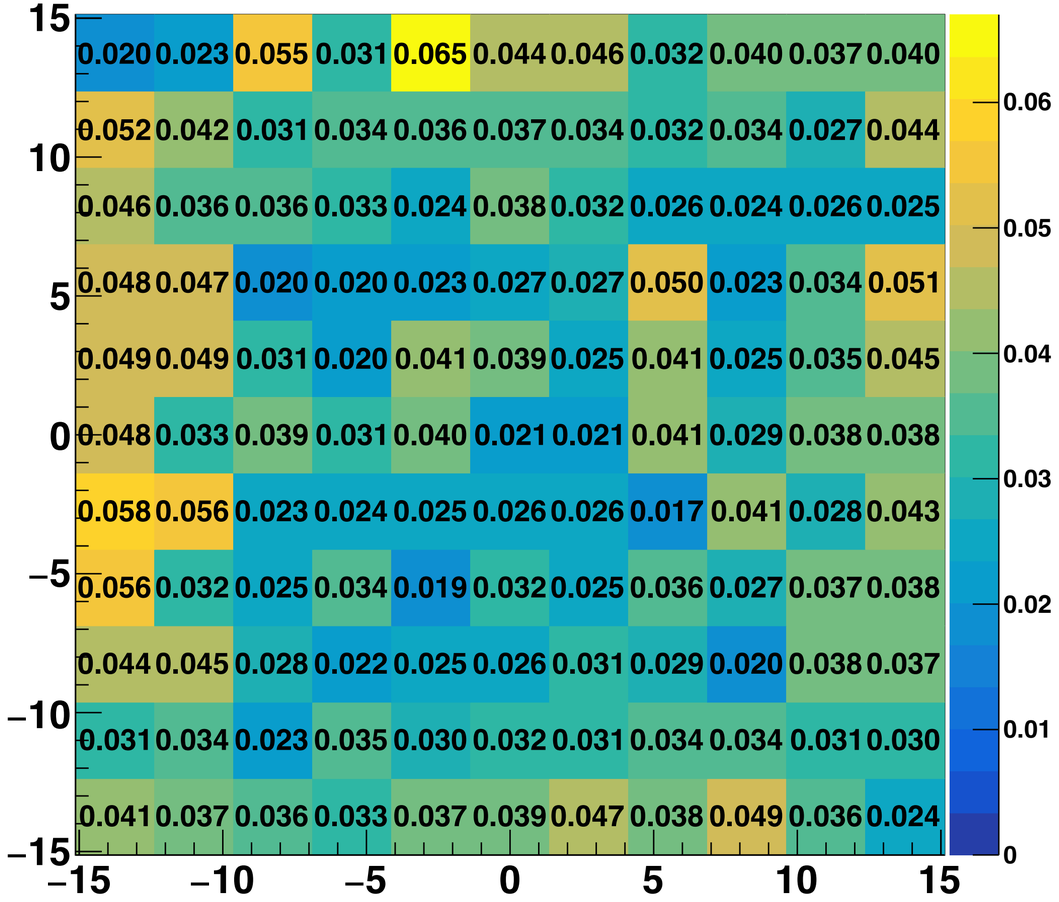
• Geometry 5 AIR



statistic 11.000 - muon 1 GeV

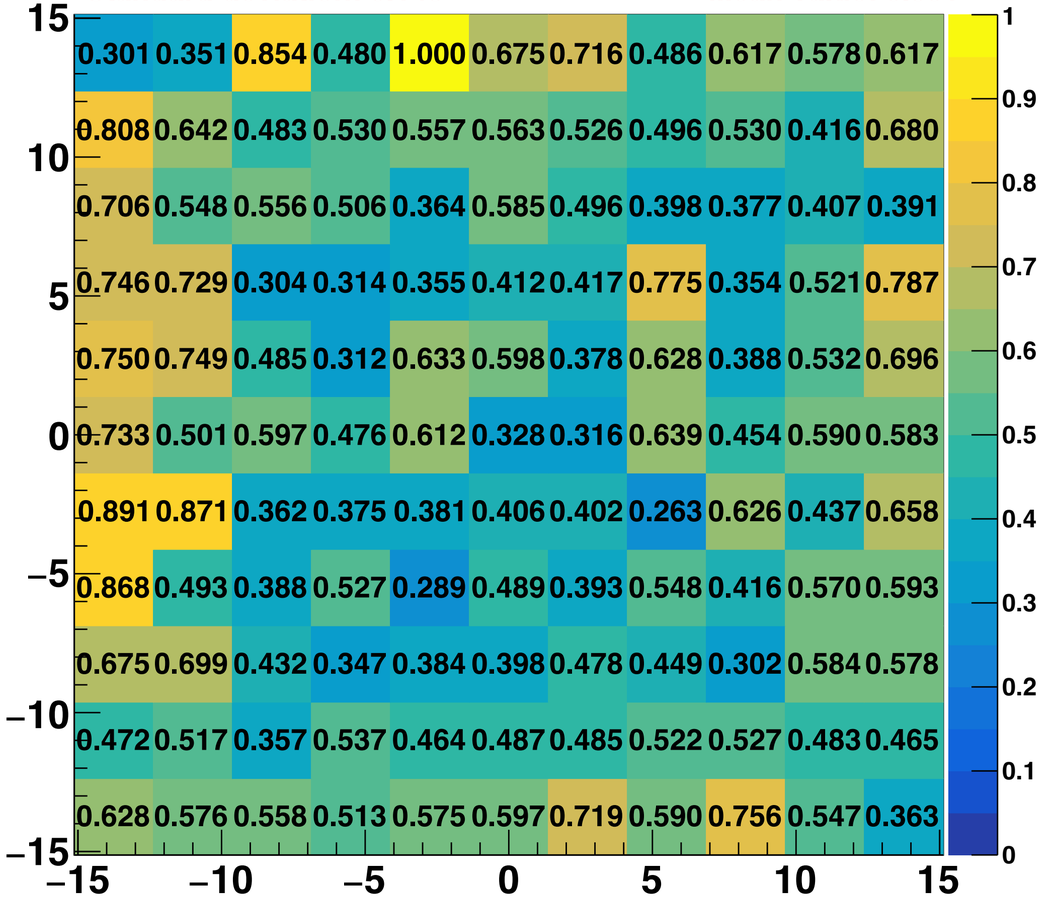
FISH TAIL
PMT 4.5

Efficiency - LG - Air - 4cm - base round - 4.5 mm

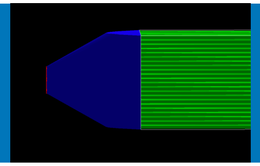


Factor non-uniformity - LG - Air - 4cm - base round - 4.5 mm

Standard deviation: 0.148 **Mean value: 0.531**



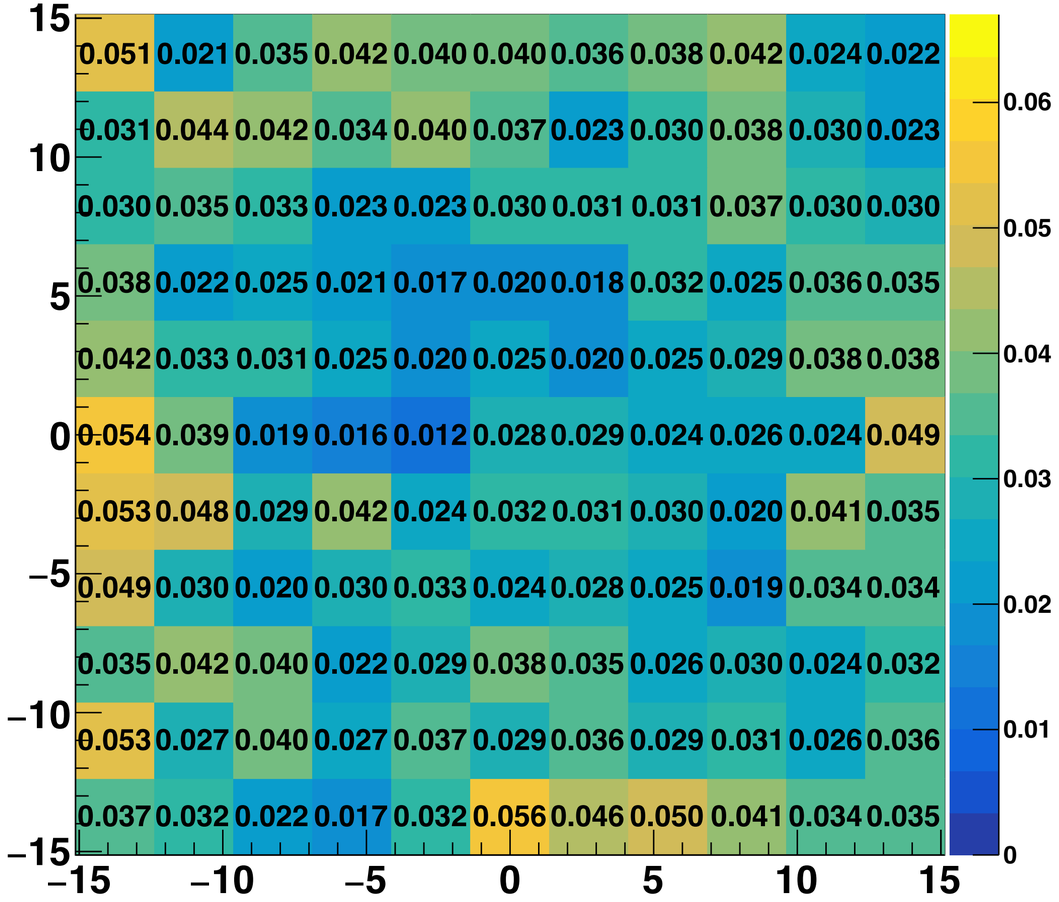
• Geometry 5 AIR



statistic 11.000 - muon 1 GeV

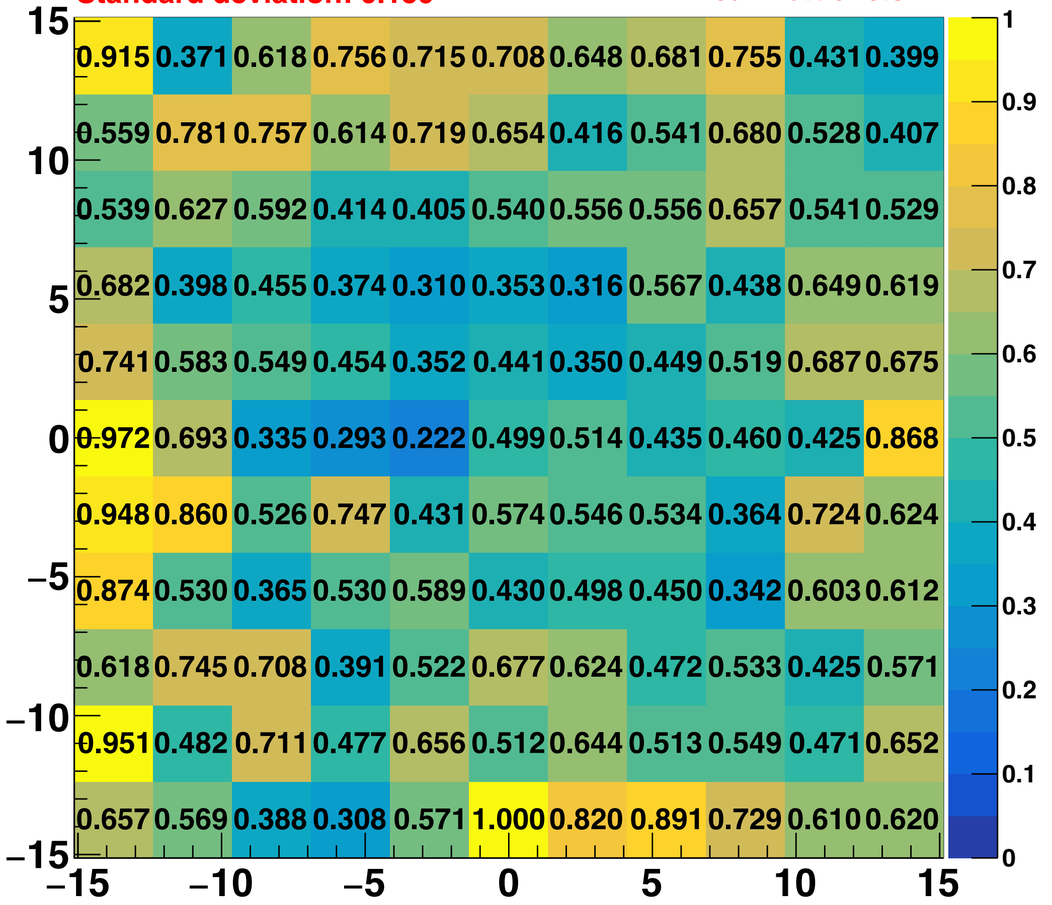
FISH TAIL
PMT 4.5

Efficiency - LG - Air - 5cm - base round - 4.5 mm

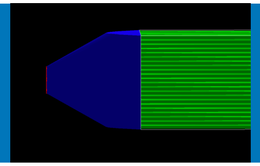


Factor non-uniformity - LG - Air - 5cm - base round - 4.5 mm

Standard deviation: 0.159 **Mean value: 0.571**



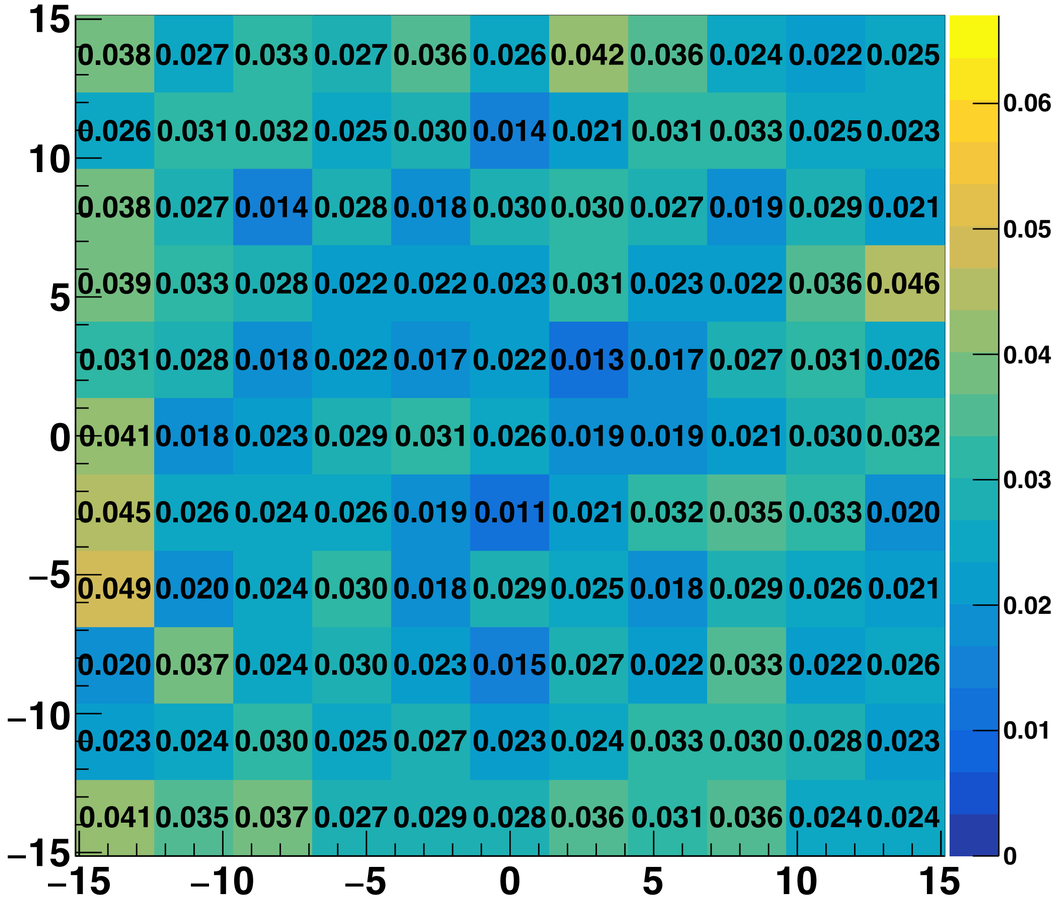
• Geometry 5 AIR



statistic 11.000 - muon 1 GeV

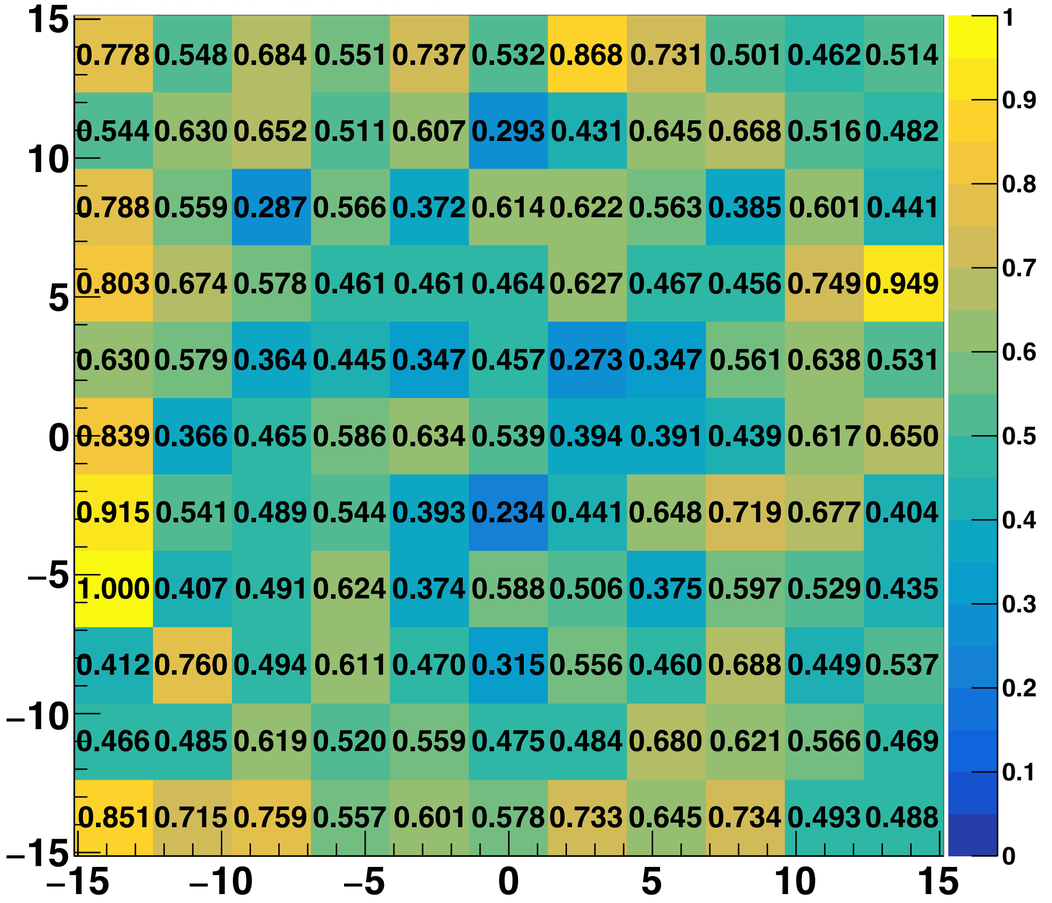
FISH TAIL
PMT 4.5

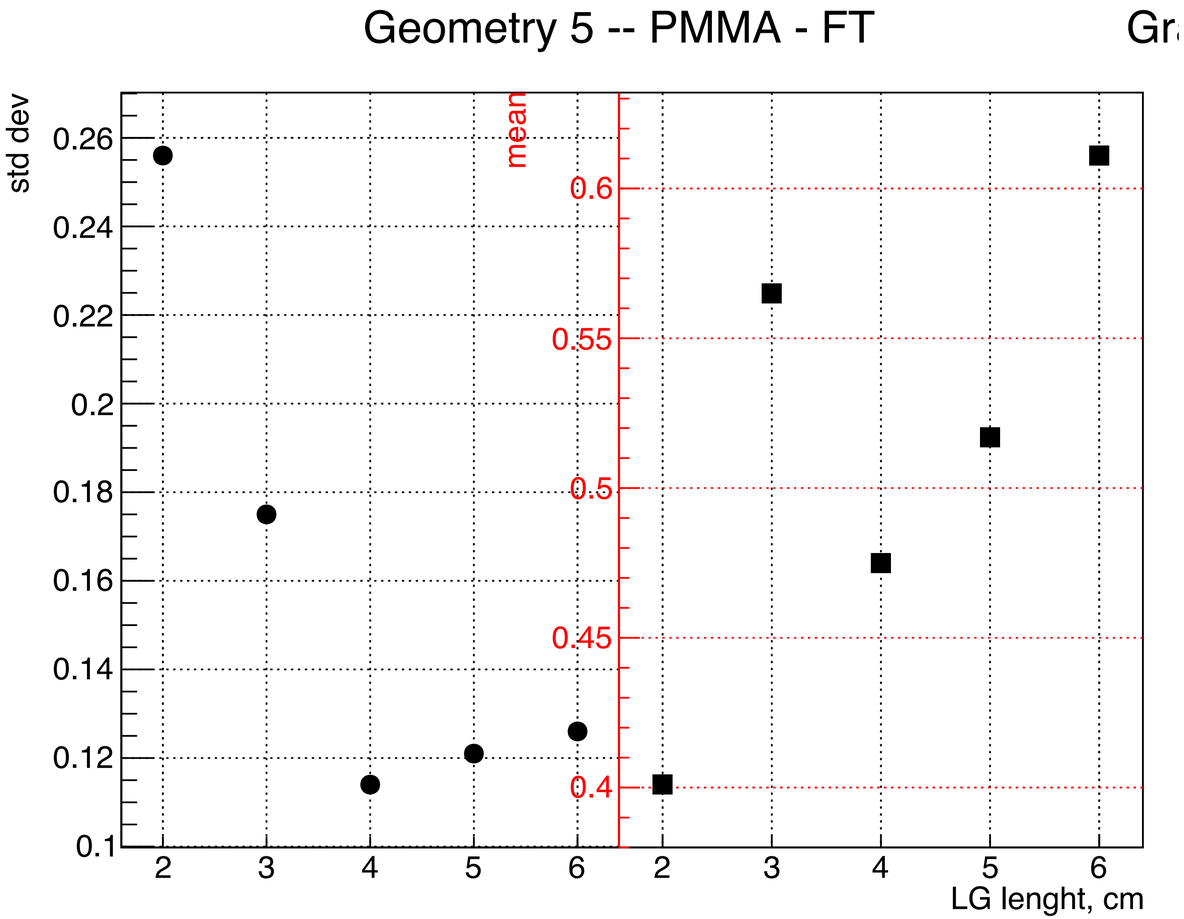
Efficiency - LG - Air - 6cm - base round - 4.5 mm

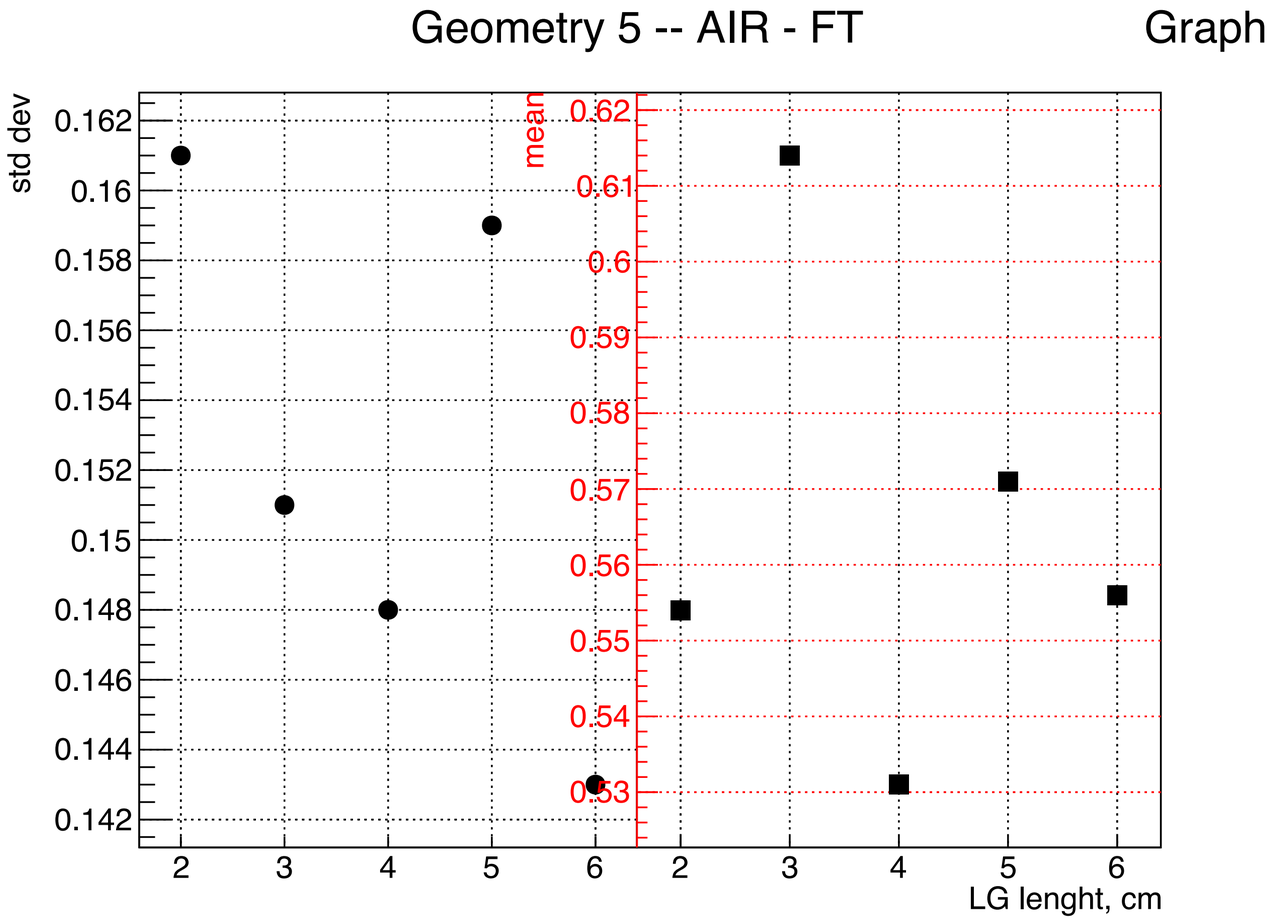


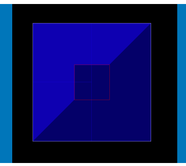
Factor non-uniformity - LG - Air - 6cm - base round - 4.5 mm

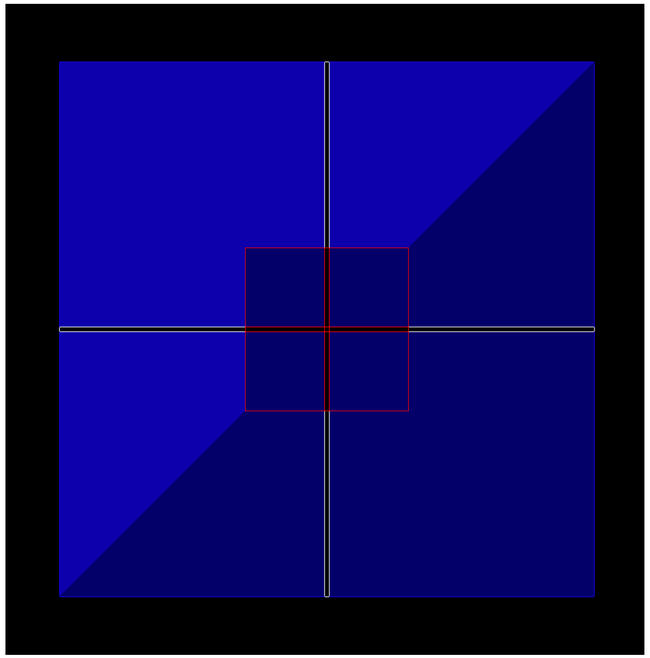
Standard deviation: 0.143 **Mean value: 0.556**

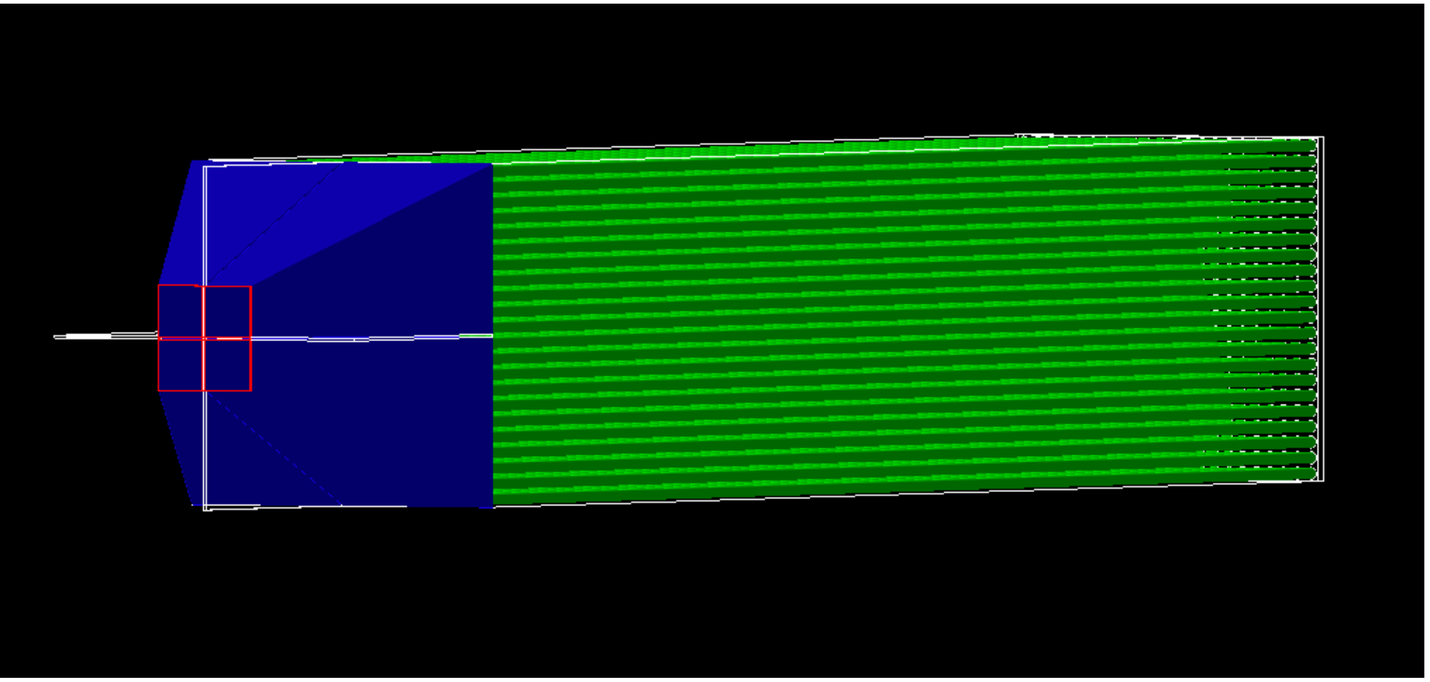


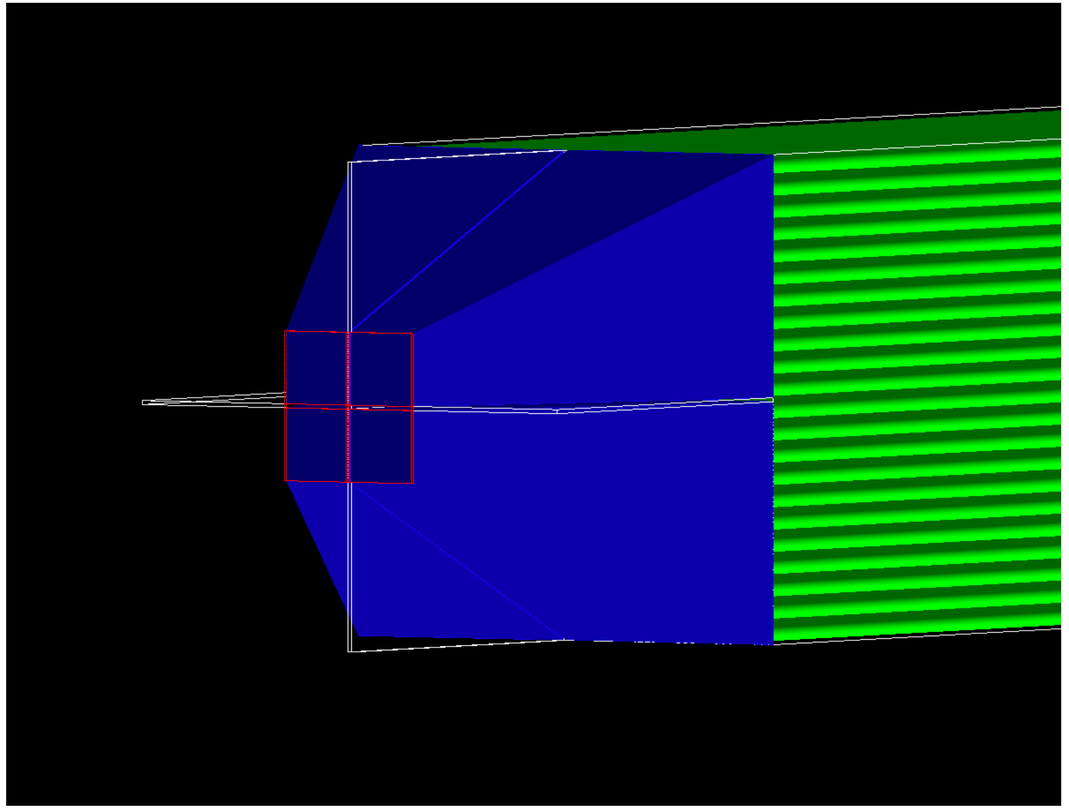

Geometry 5 -- PMMA - FT
std dev
mean
LG lenght, cm

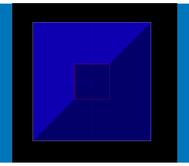

Geometry 5 -- AIR - FT
std dev
mean
LG lenght, cm

- **Geometry 6** PMMA  **22x22 — Trap — 18 mm**

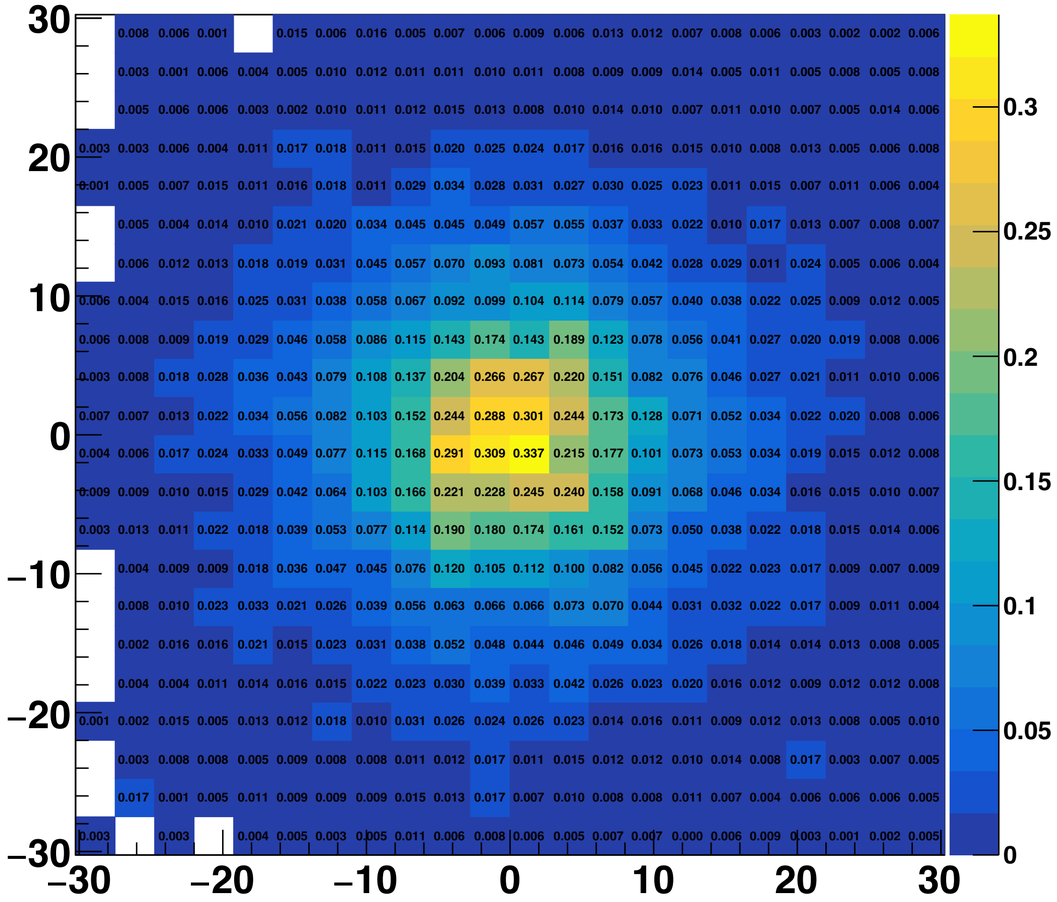






• Geometry 6 PMMA  22x22 — Trap — 18 mm

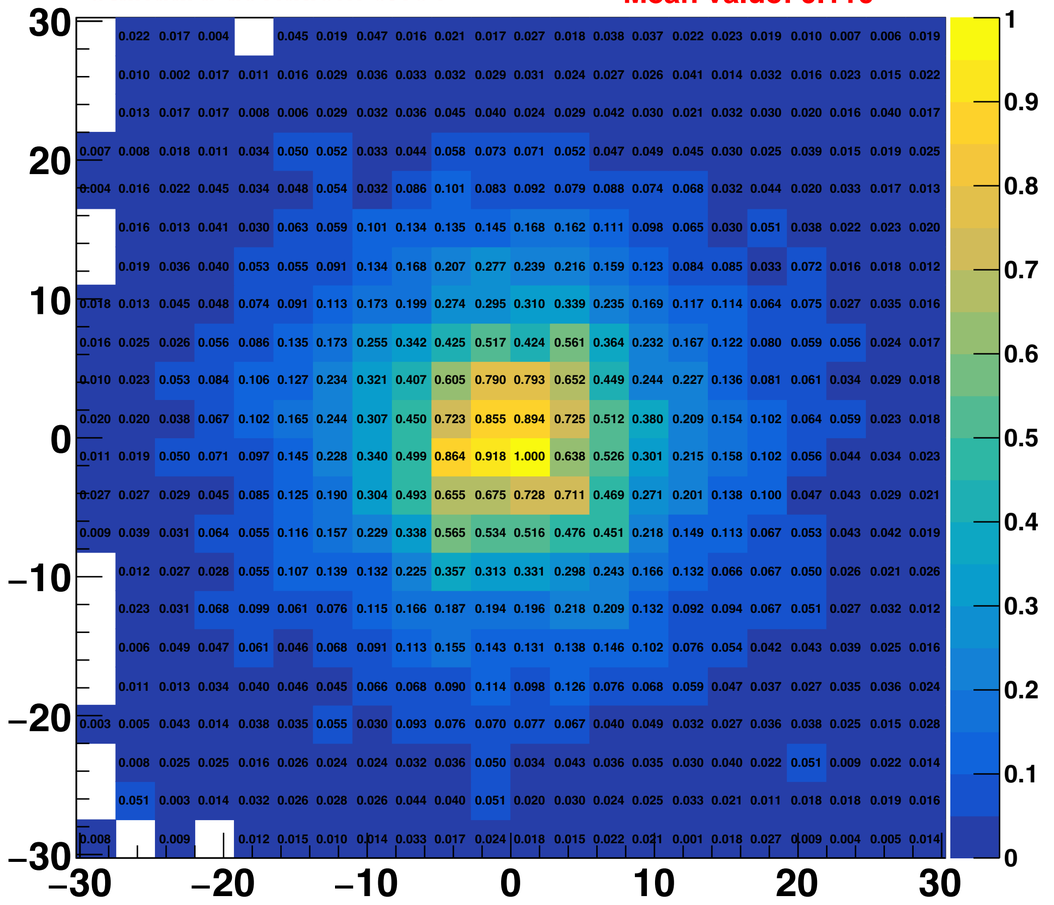
Efficiency - LG - PMMA - 2cm - 22x22 - 18. mm



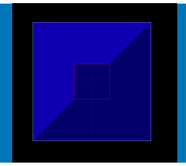
Factor non-uniformity - LG - PMMA - 2cm - 22x22 - 18. mm

Standard deviation: 0.164

Mean value: 0.110

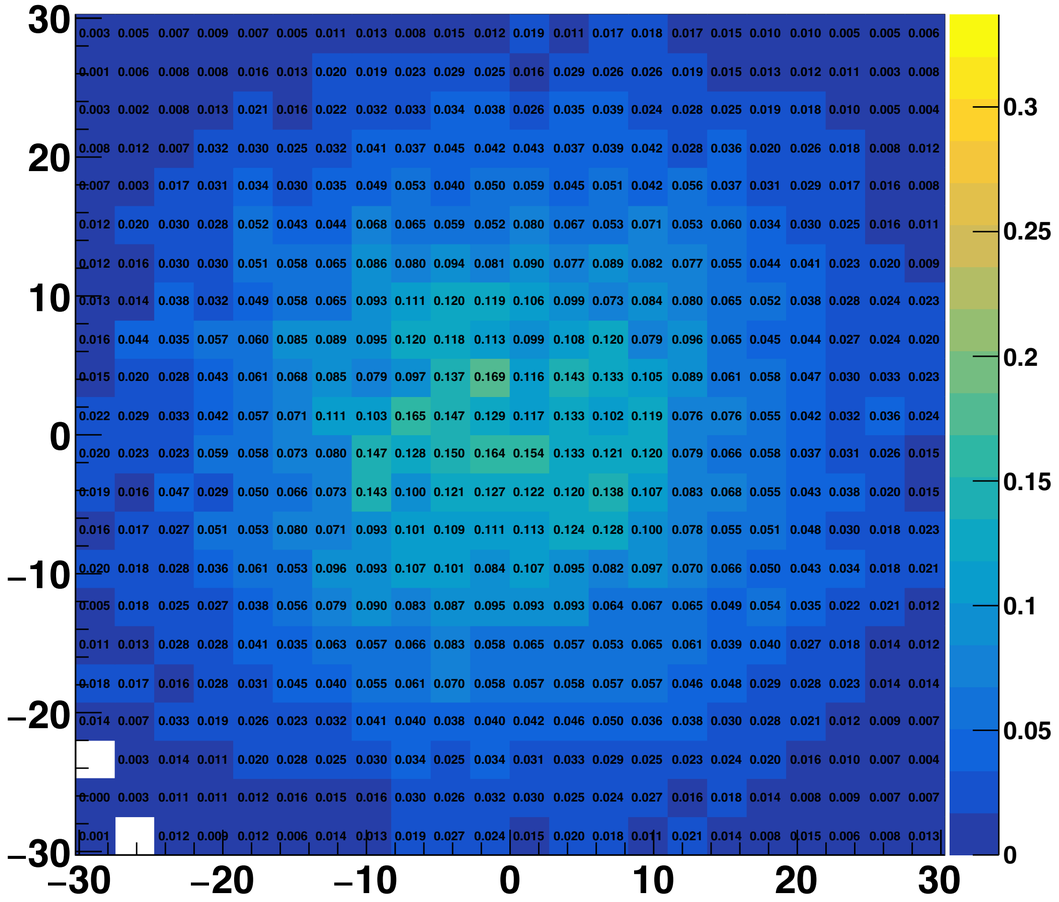


• Geometry 6 PMMA



22x22 — Trap — 18 mm

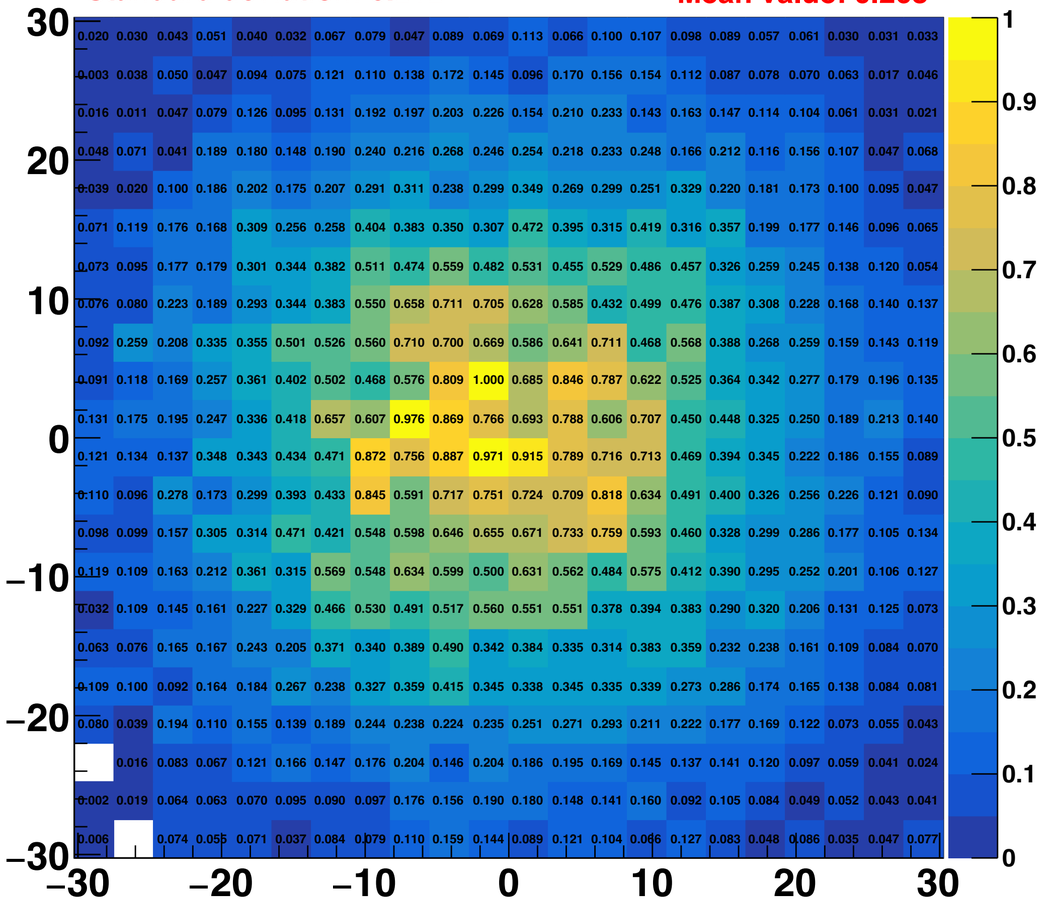
Efficiency - LG - PMMA - 3cm - 22x22 - 18. mm



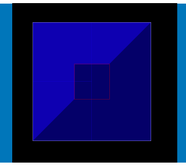
Factor non-uniformity - LG - PMMA - 3cm - 22x22 - 18. mm

Standard deviation: 0.212

Mean value: 0.268

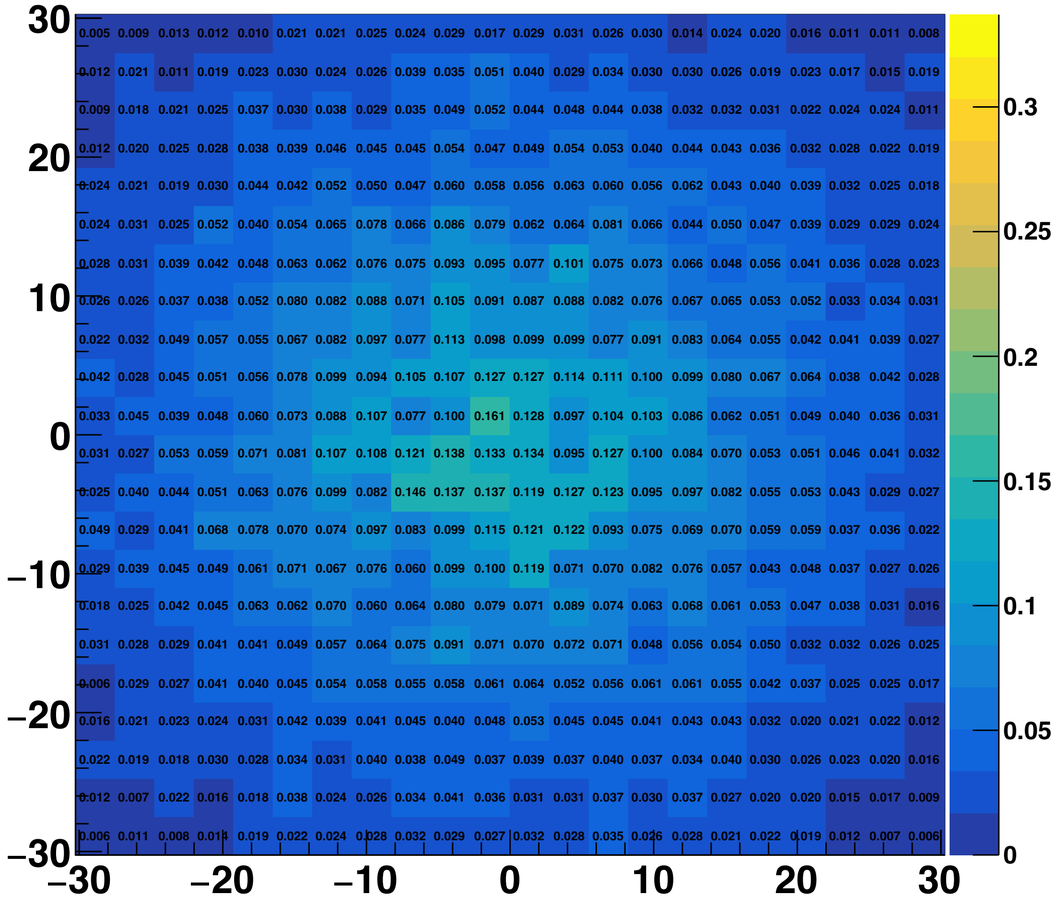


• Geometry 6 PMMA



22x22 — Trap — 18 mm

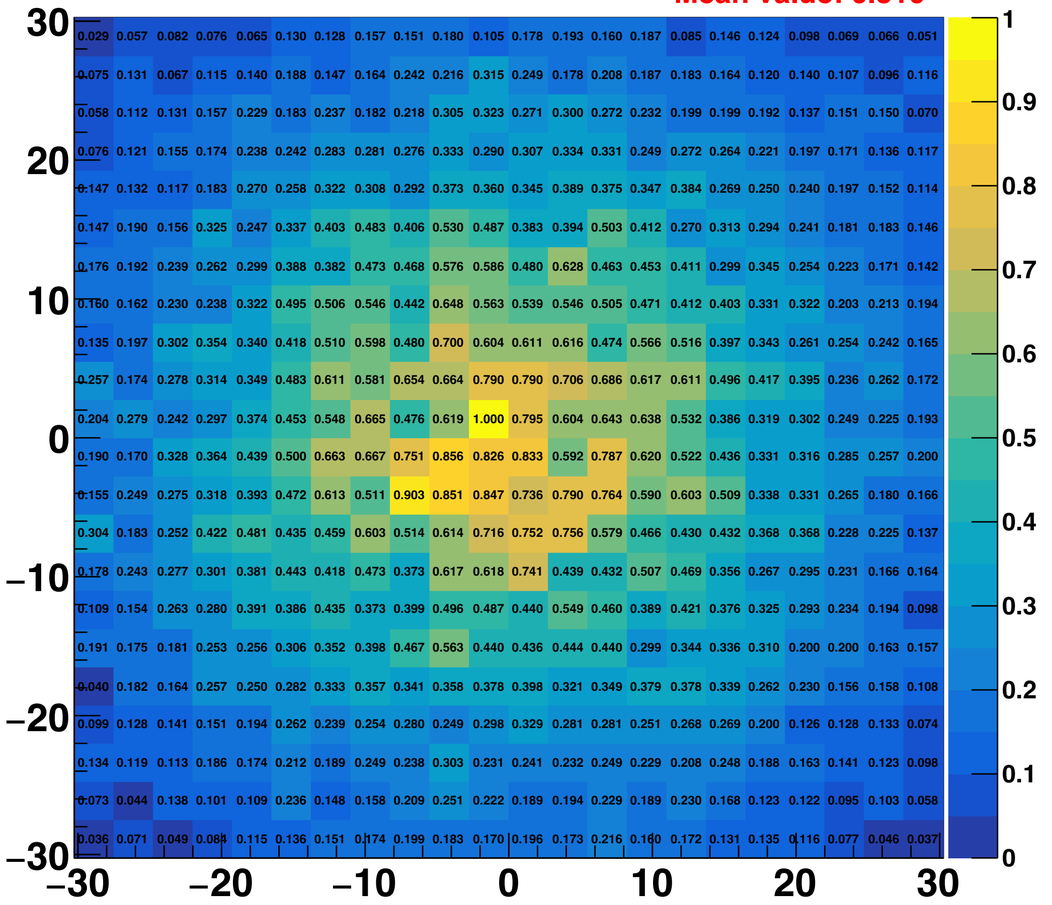
Efficiency - LG - PMMA - 4cm - 22x22 - 18. mm



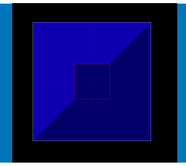
Factor non-uniformity - LG - PMMA - 4cm - 22x22 - 18. mm

Standard deviation: 0.182

Mean value: 0.310

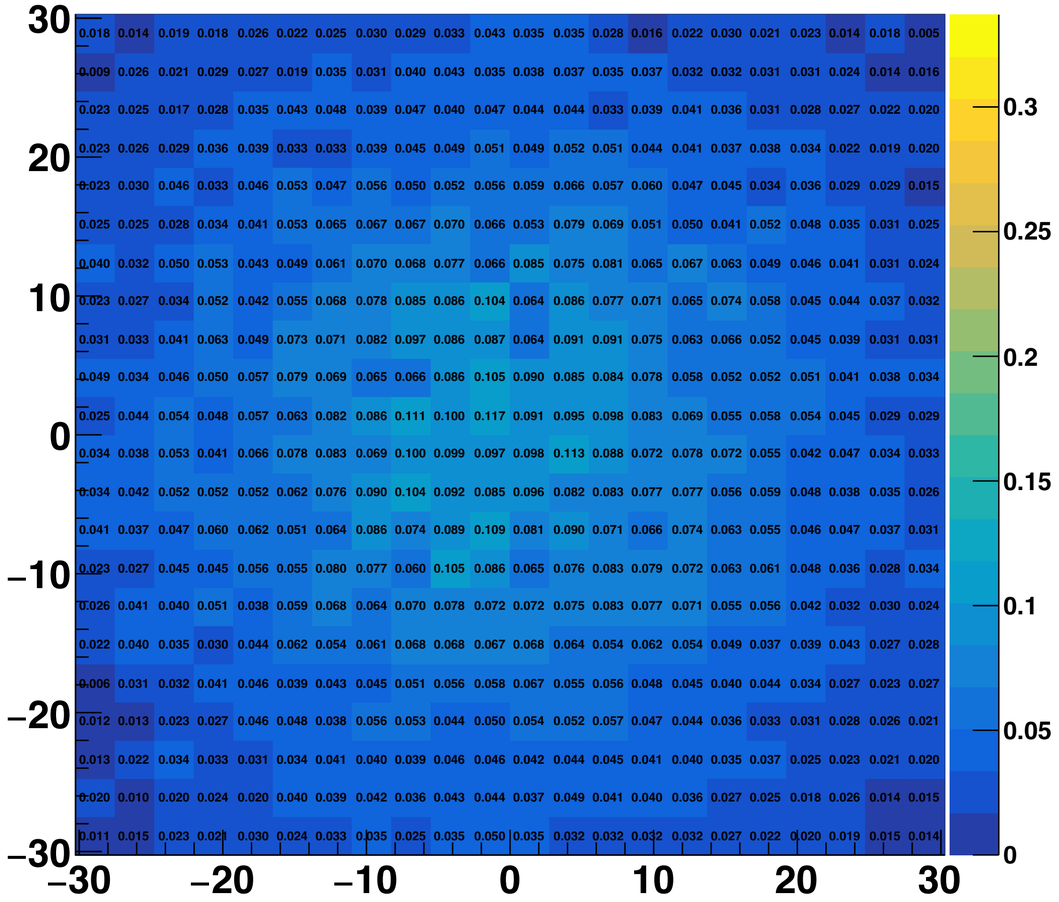


• Geometry 6 PMMA



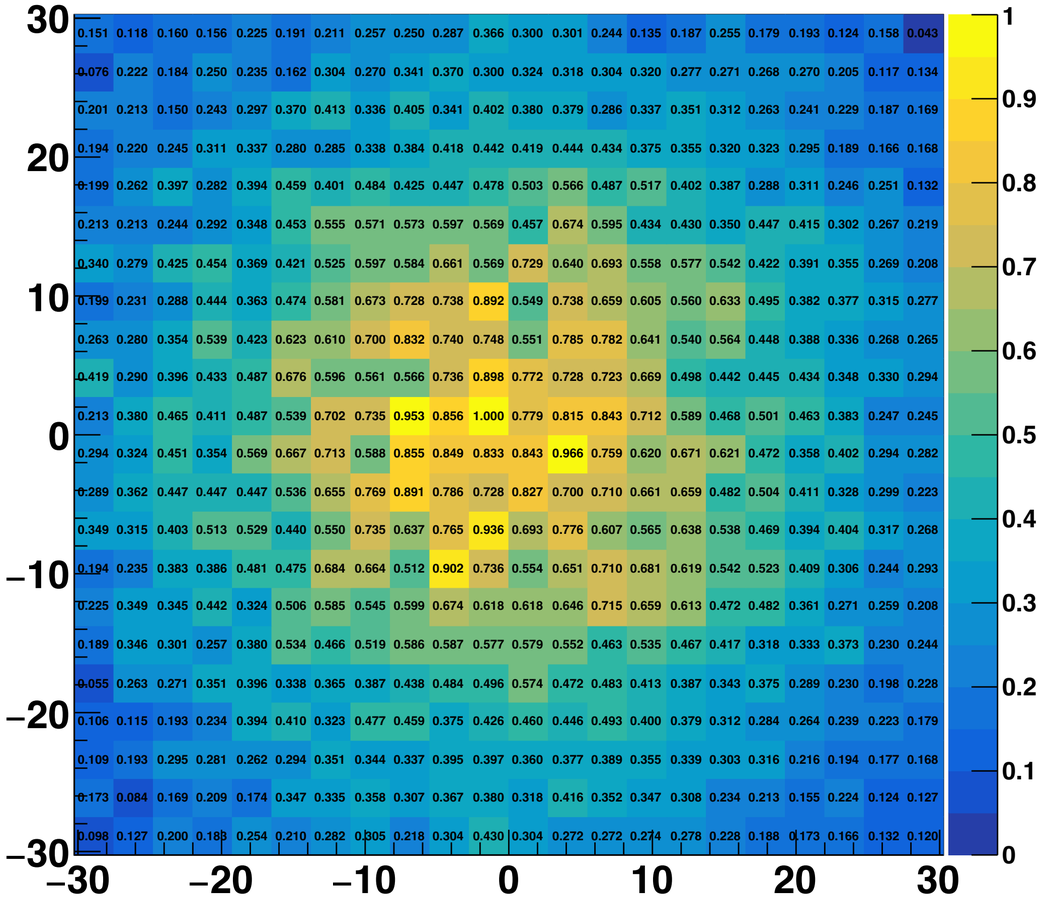
22x22 — Trap — 18 mm

Efficiency - LG - PMMA - 5cm - 22x22 - 18. mm

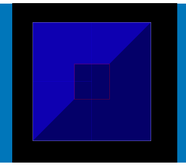


Factor non-uniformity - LG - PMMA - 5cm - 22x22 - 18. mm

Standard deviation: 0.189 **Mean value: 0.411**

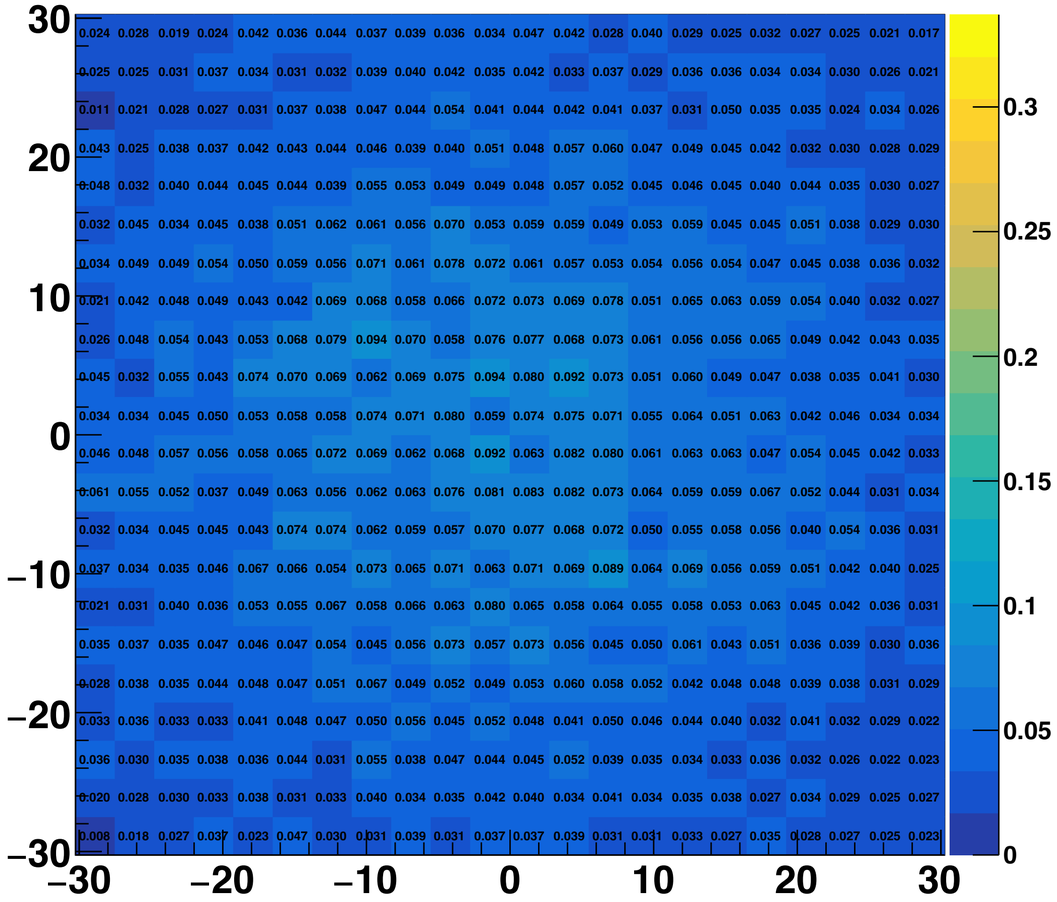


• Geometry 6 PMMA



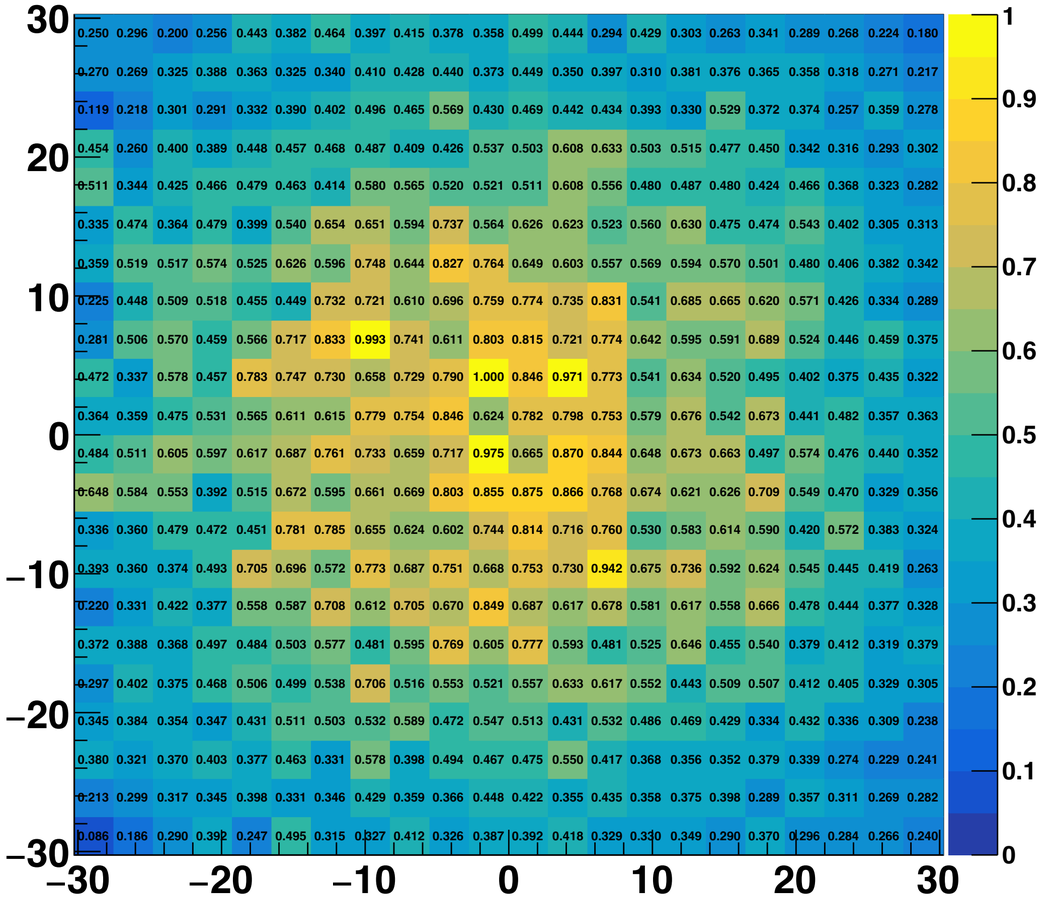
22x22 — Trap — 18 mm

Efficiency - LG - PMMA - 6cm - 22x22 - 18. mm

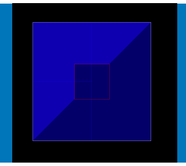


Factor non-uniformity - LG - PMMA - 6cm - 22x22 - 18. mm

Standard deviation: 0.164 **Mean value: 0.496**

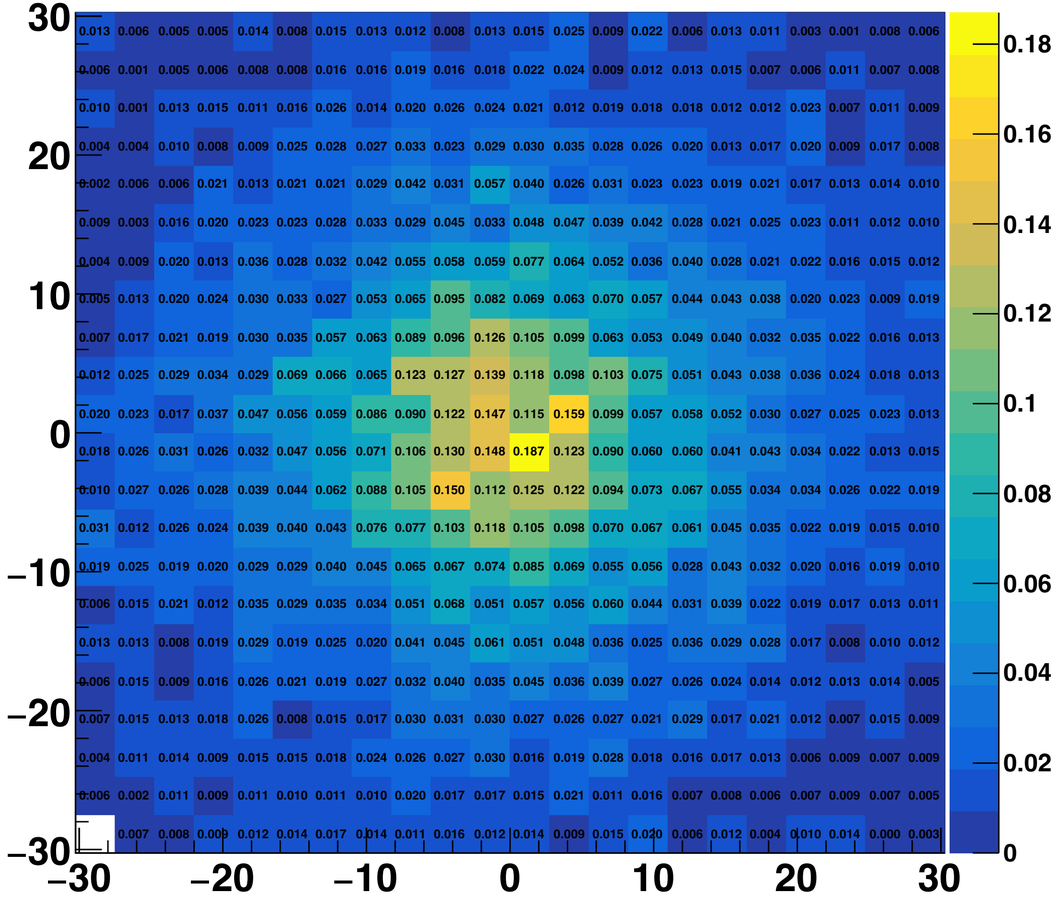


• Geometry 6 Air



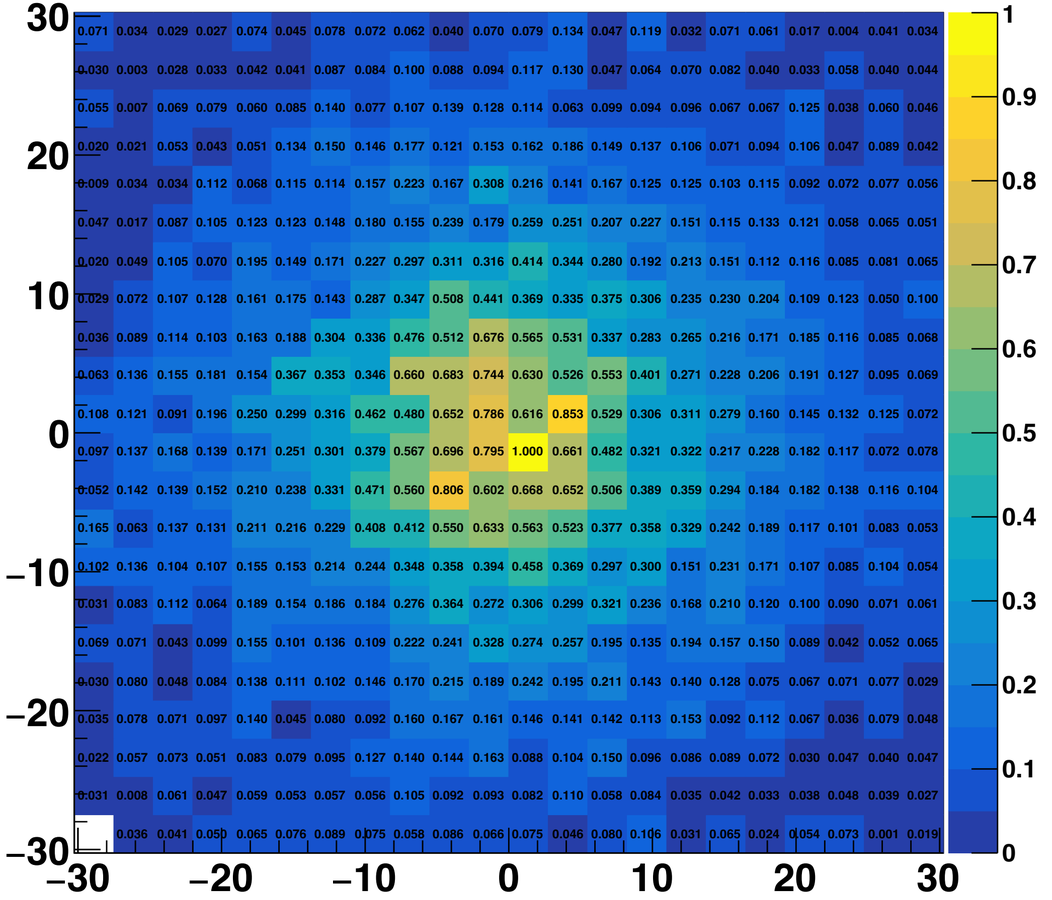
22x22 — Trap — 18 mm

Efficiency - LG - AIR - 2cm - 22x22 - 18. mm

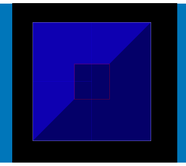


Factor non-uniformity - LG - Air - 2cm - 22x22 - 18. mm

Standard deviation: 0.159 **Mean value: 0.172**

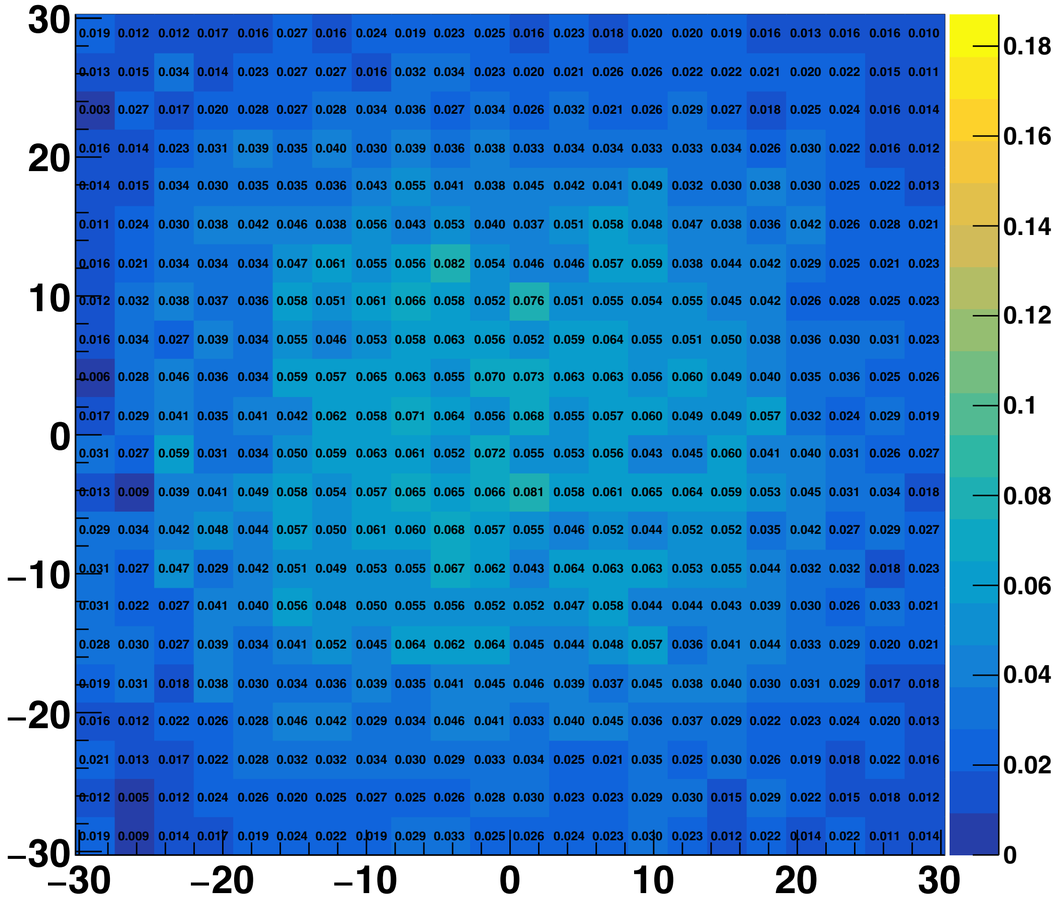


• Geometry 6 Air



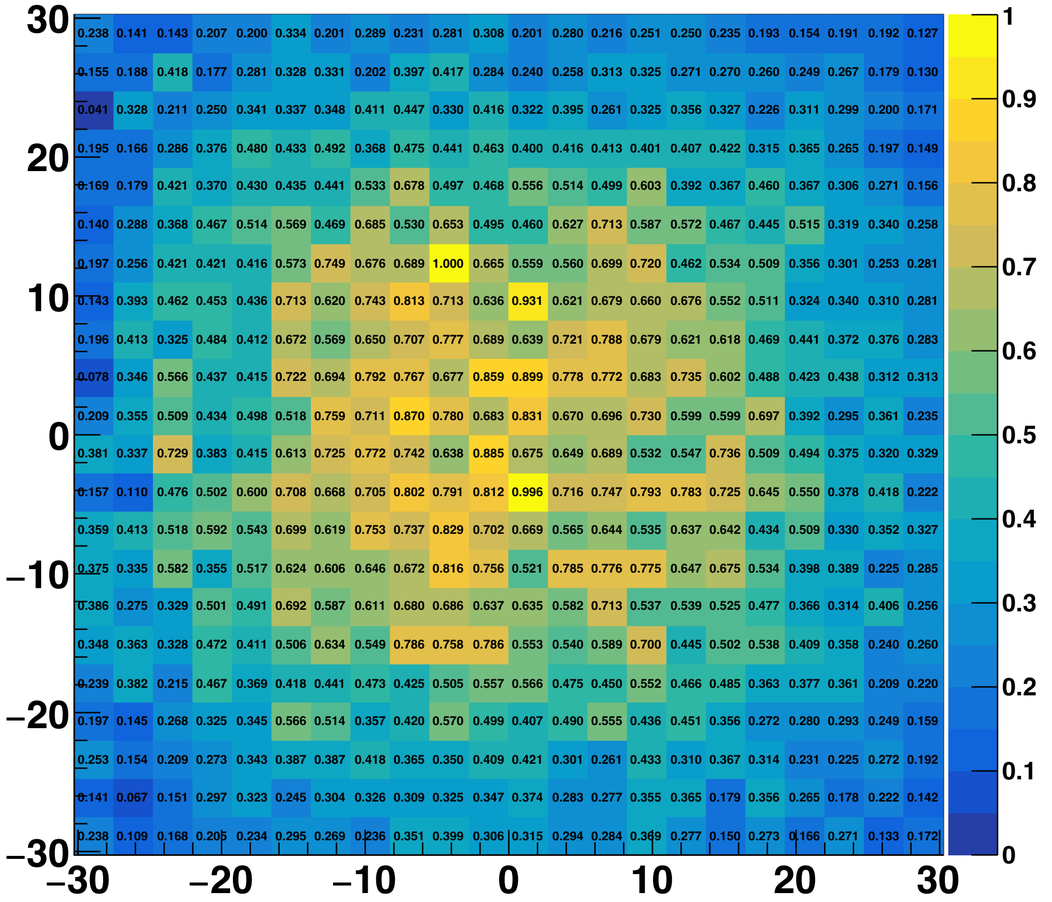
22x22 — Trap — 18 mm

Efficiency - LG - AIR - 3cm - 22x22 - 18. mm

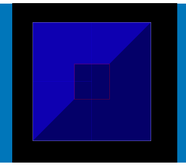


Factor non-uniformity - LG - Air - 3cm - 22x22 - 18. mm

Standard deviation: 0.191 **Mean value: 0.441**

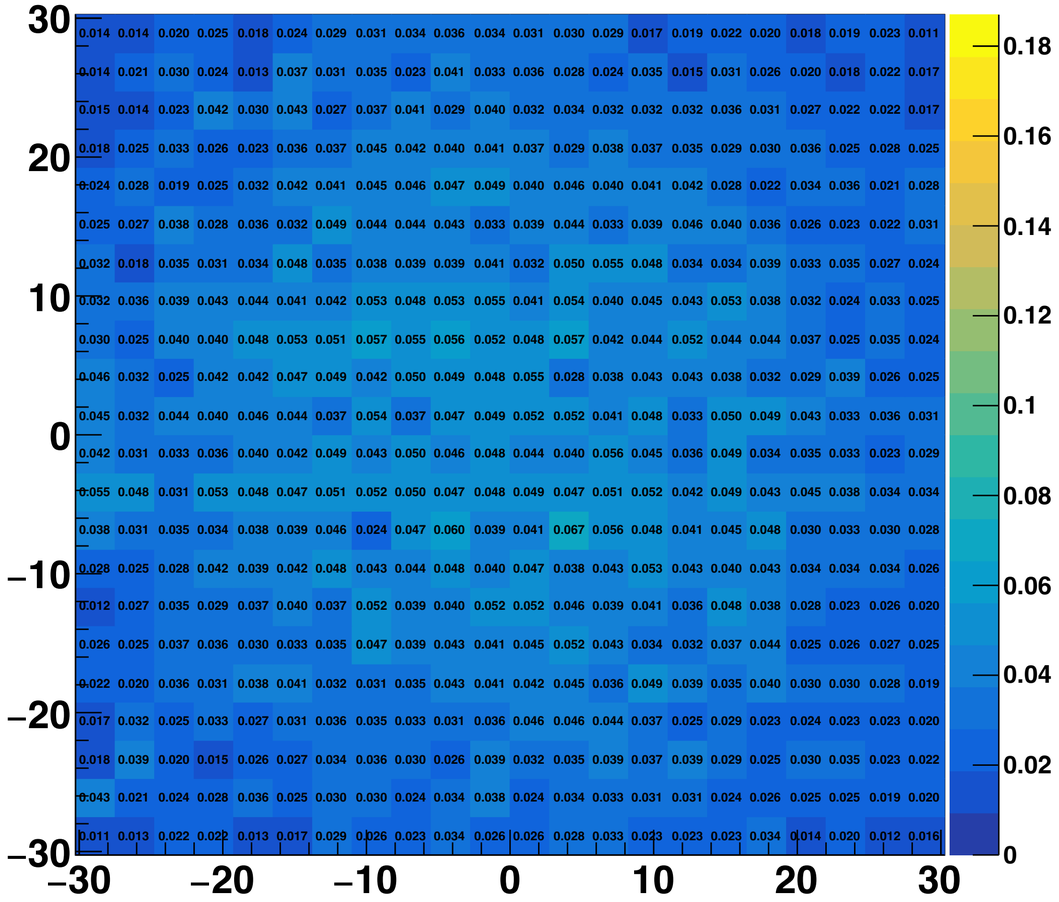


• Geometry 6 Air



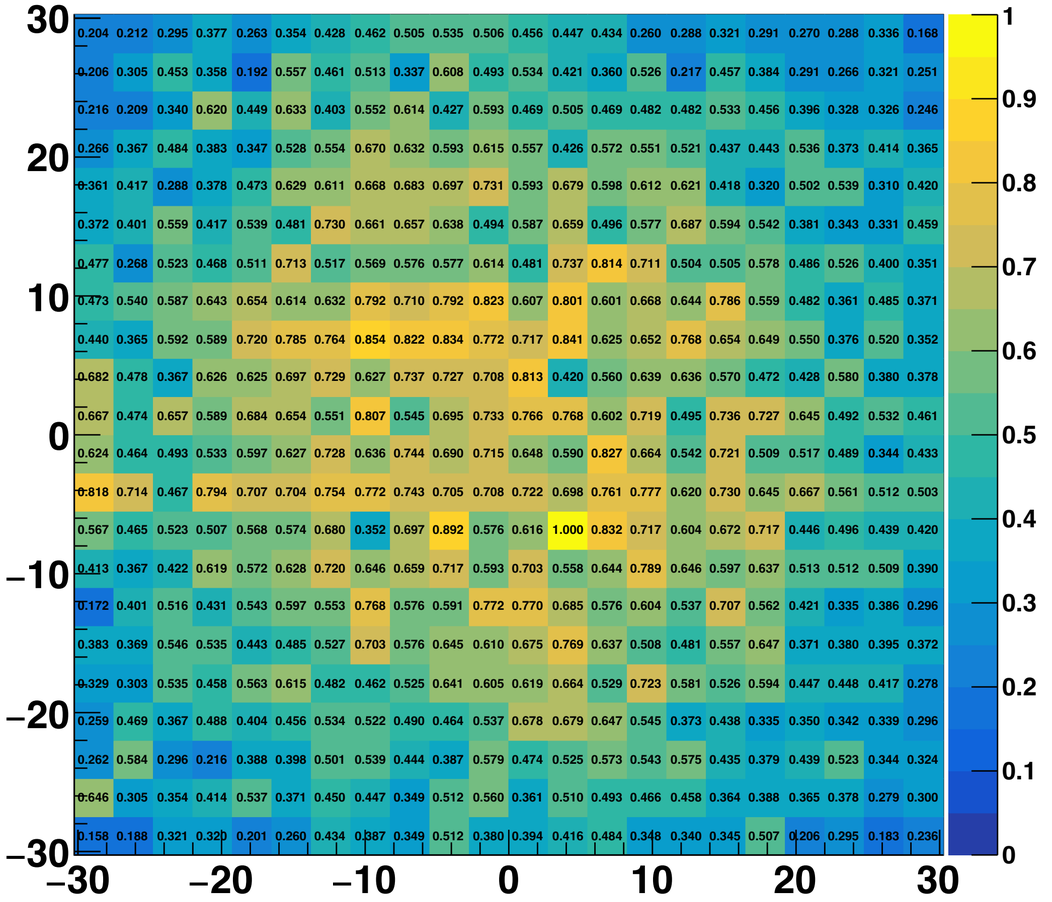
22x22 — Trap — 18 mm

Efficiency - LG - AIR - 4cm - 22x22 - 18. mm

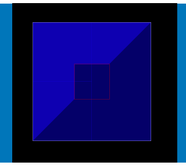


Factor non-uniformity - LG - Air - 4cm - 22x22 - 18. mm

Standard deviation: 0.154 **Mean value: 0.520**

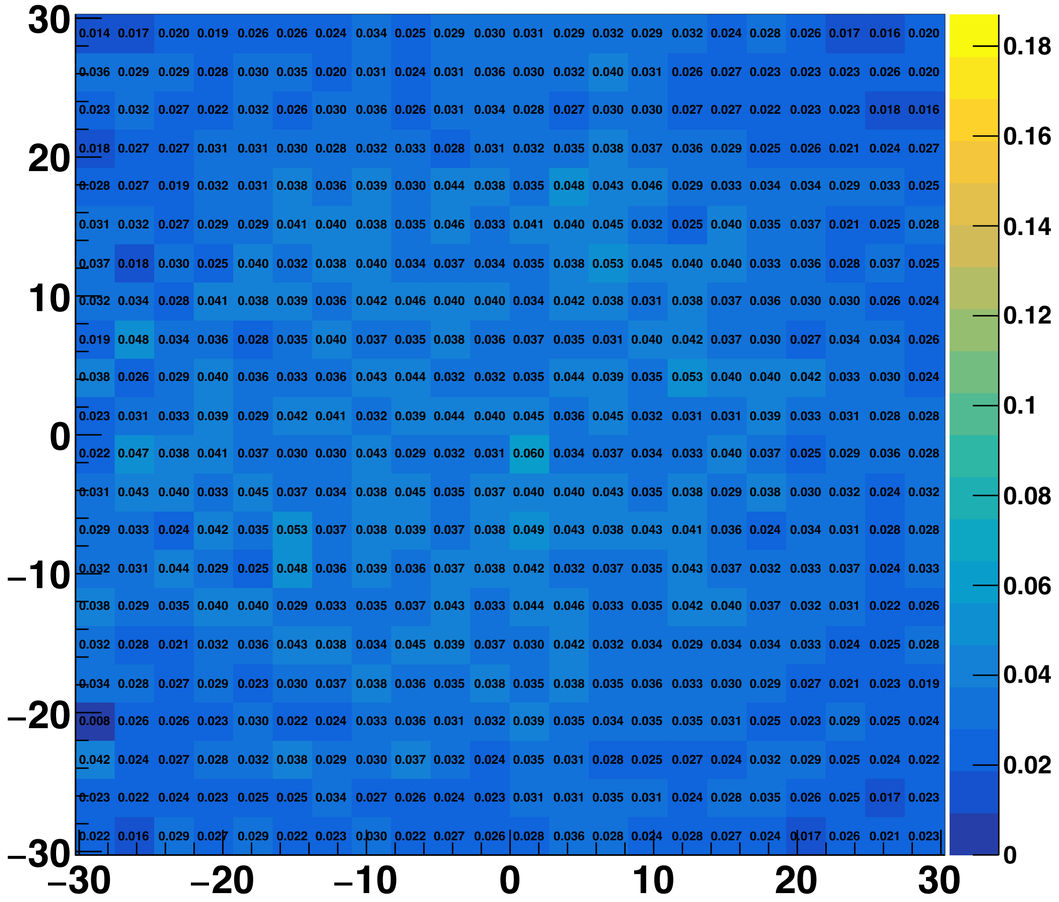


• Geometry 6 Air



22x22 — Trap — 18 mm

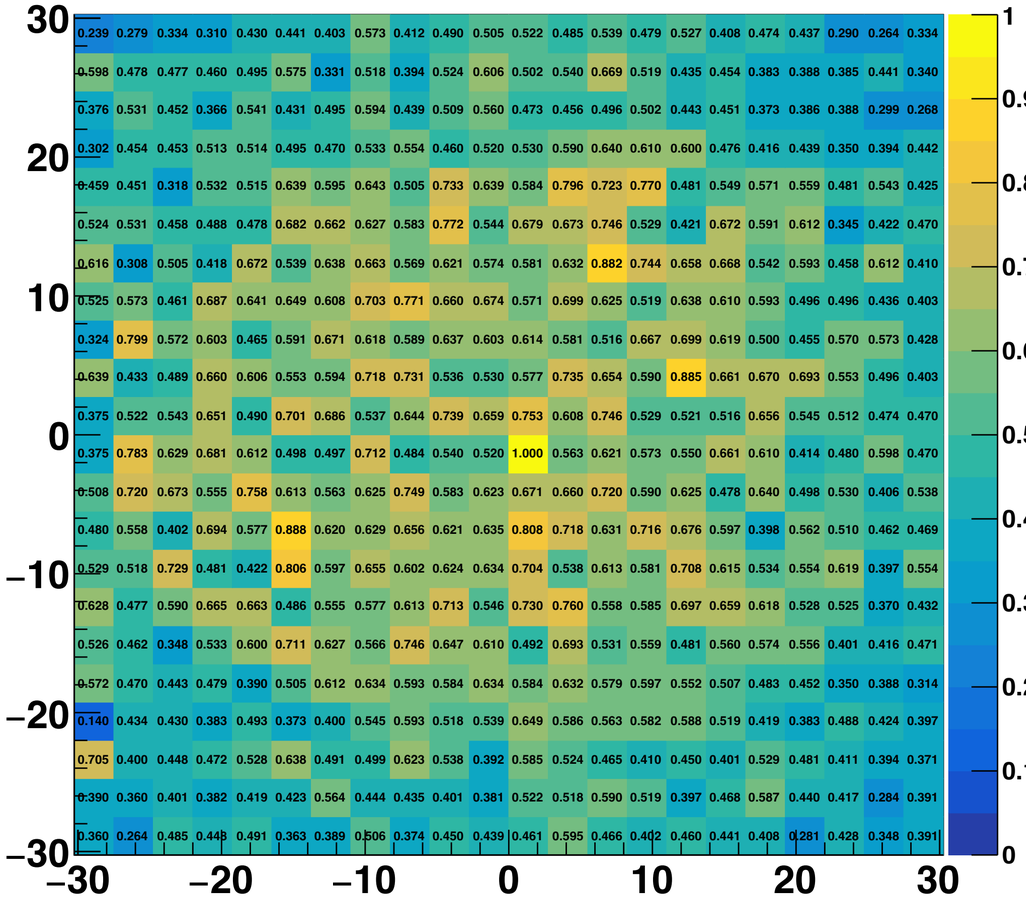
Efficiency - LG - AIR - 5cm - 22x22 - 18. mm



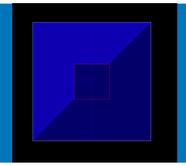
Factor non-uniformity - LG - Air - 5cm - 22x22 - 18. mm

Standard deviation: 0.118

Mean value: 0.536

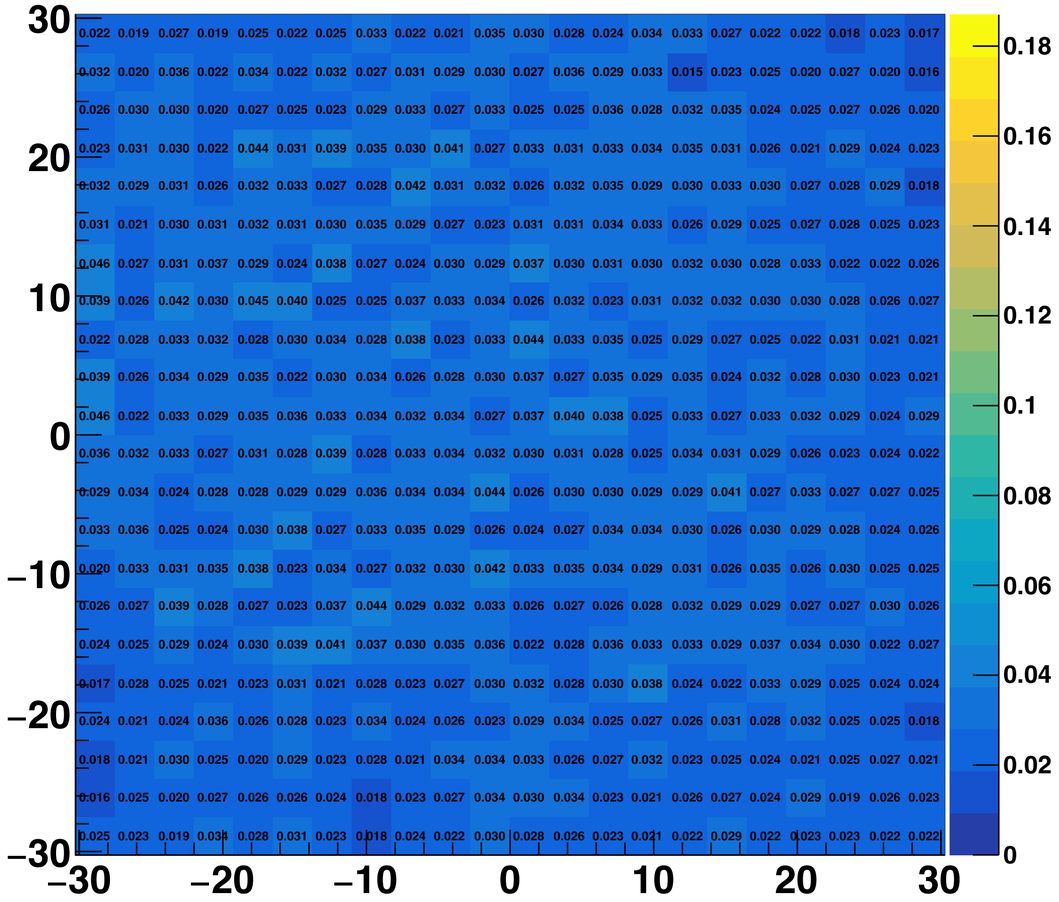


• Geometry 6 Air



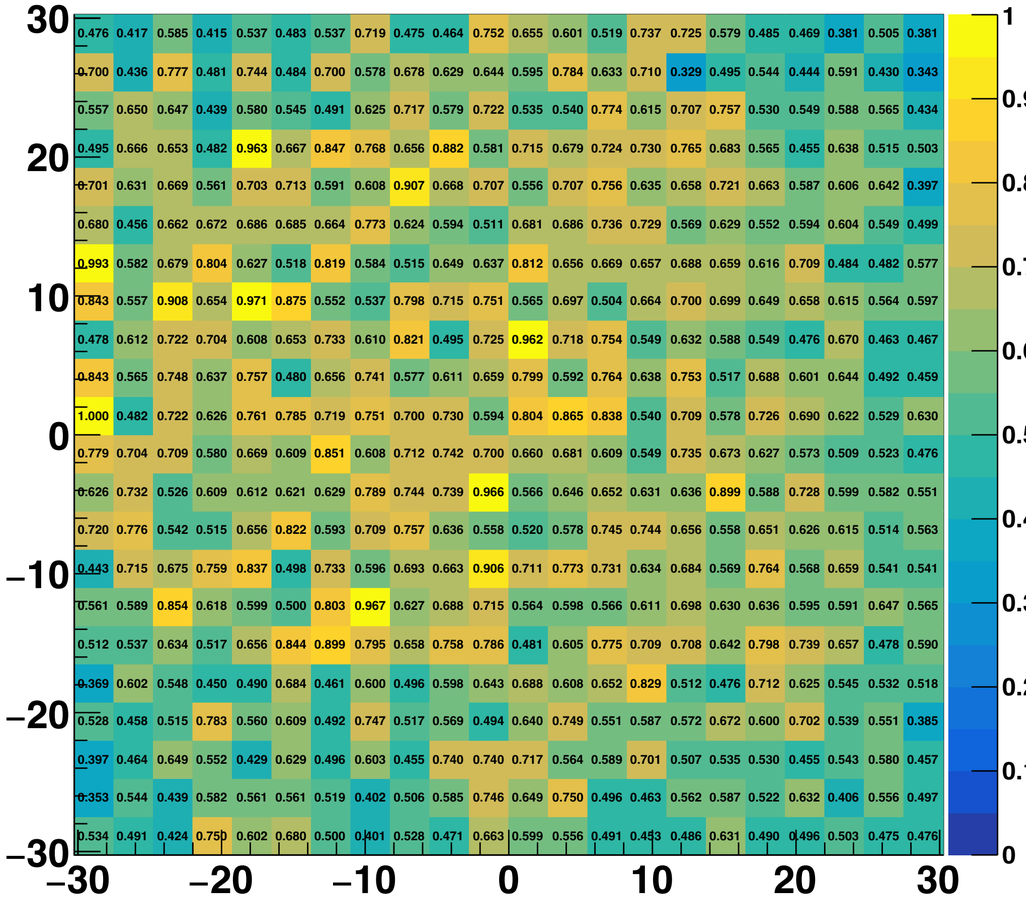
22x22 — Trap — 18 mm

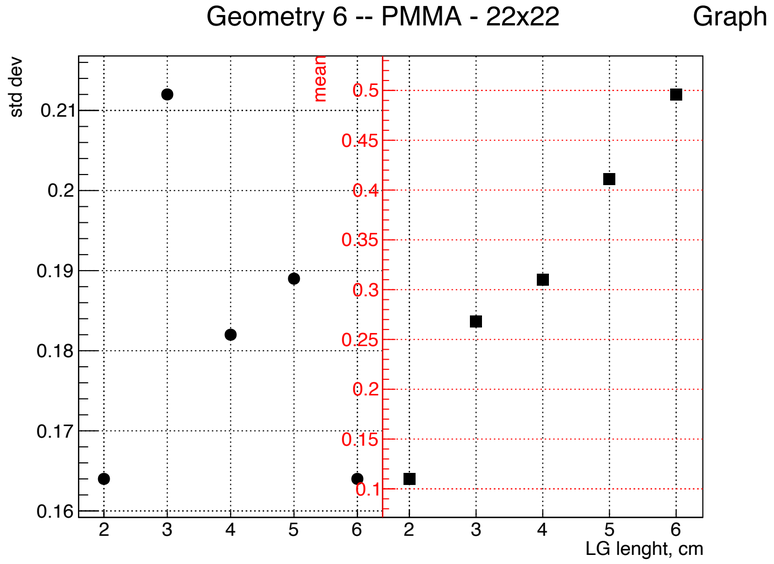
Efficiency - LG - AIR - 6cm - 22x22 - 18. mm

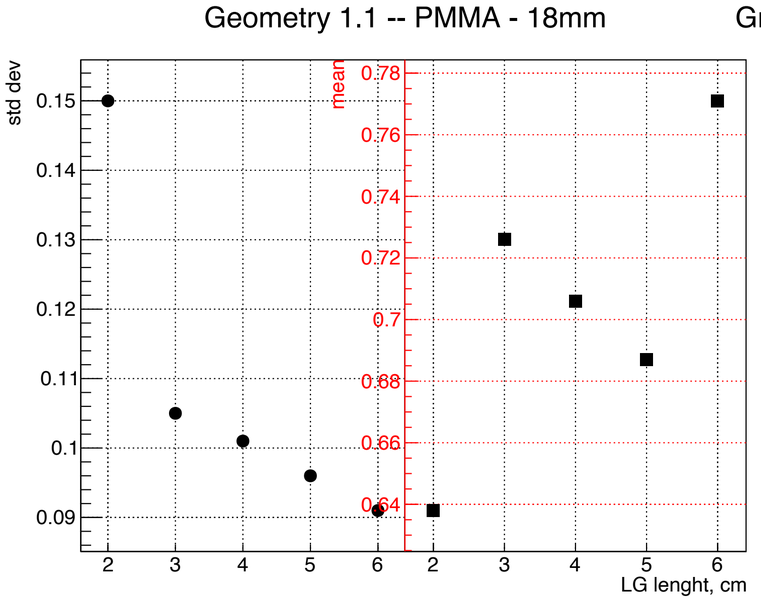


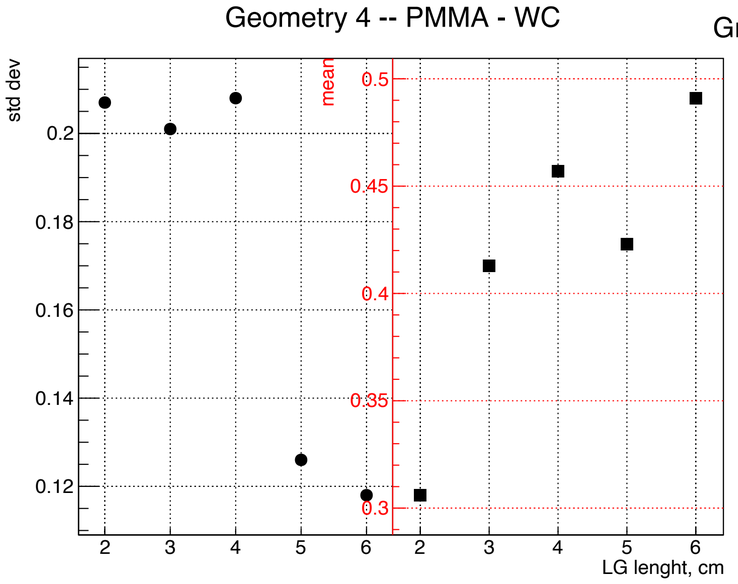
Factor non-uniformity - LG - Air - 6cm - 22x22 - 18. mm

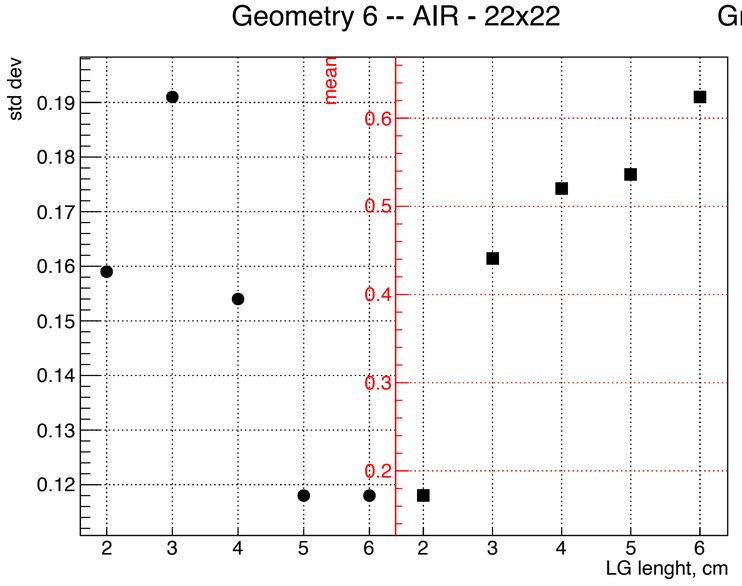
Standard deviation: 0.118 Mean value: 0.624

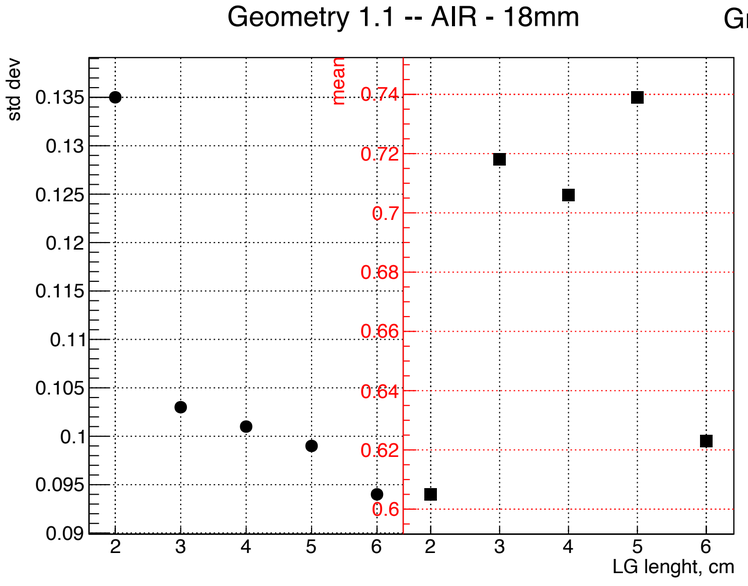


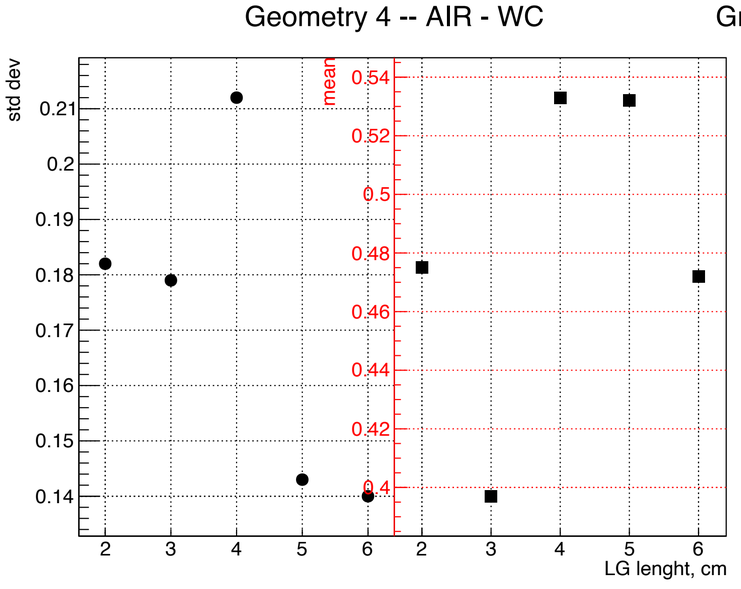

Geometry 6 -- PMMA - 22x22
Graph
std dev
mean
LG lenght, cm

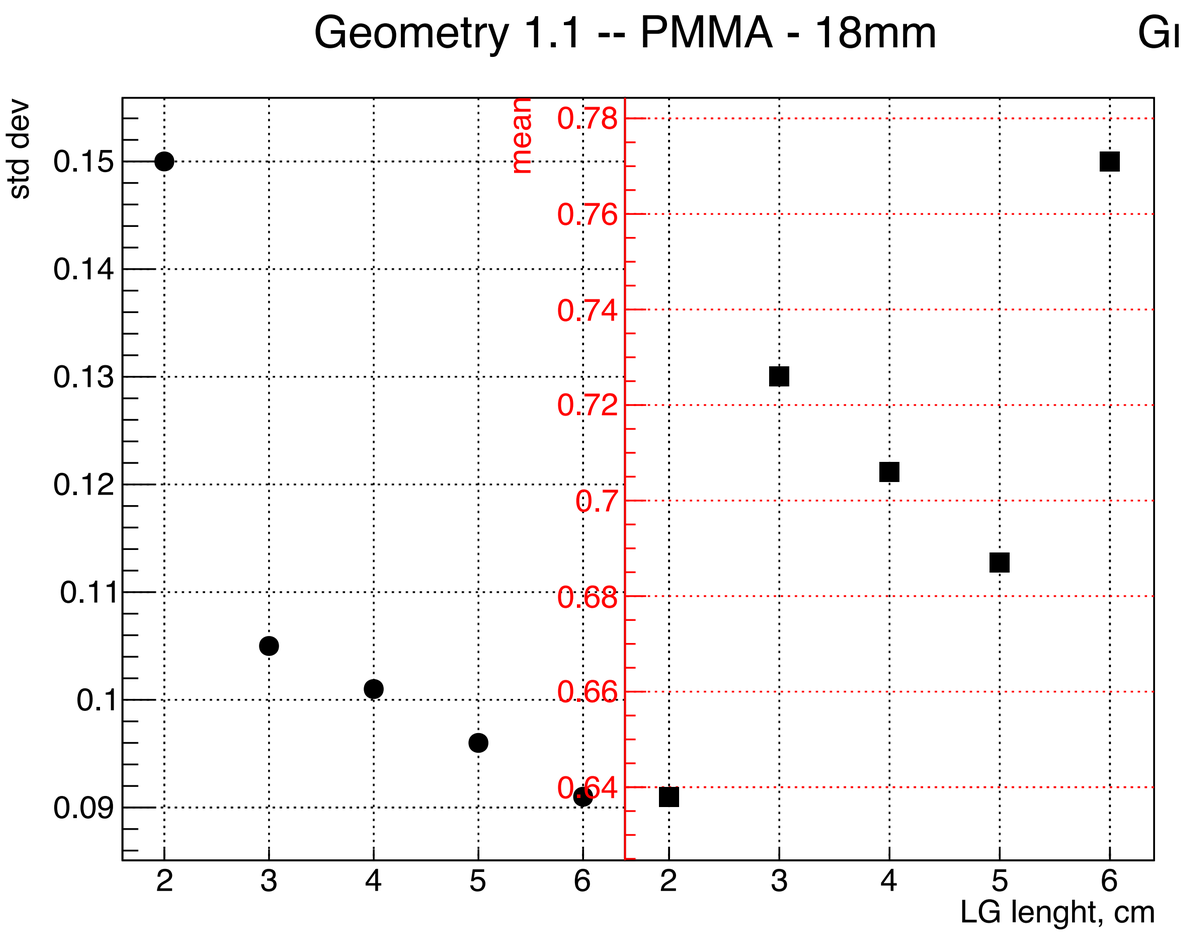

Geometry 1.1 -- PMMA - 18mm
Graph
std dev
mean
LG lenght, cm

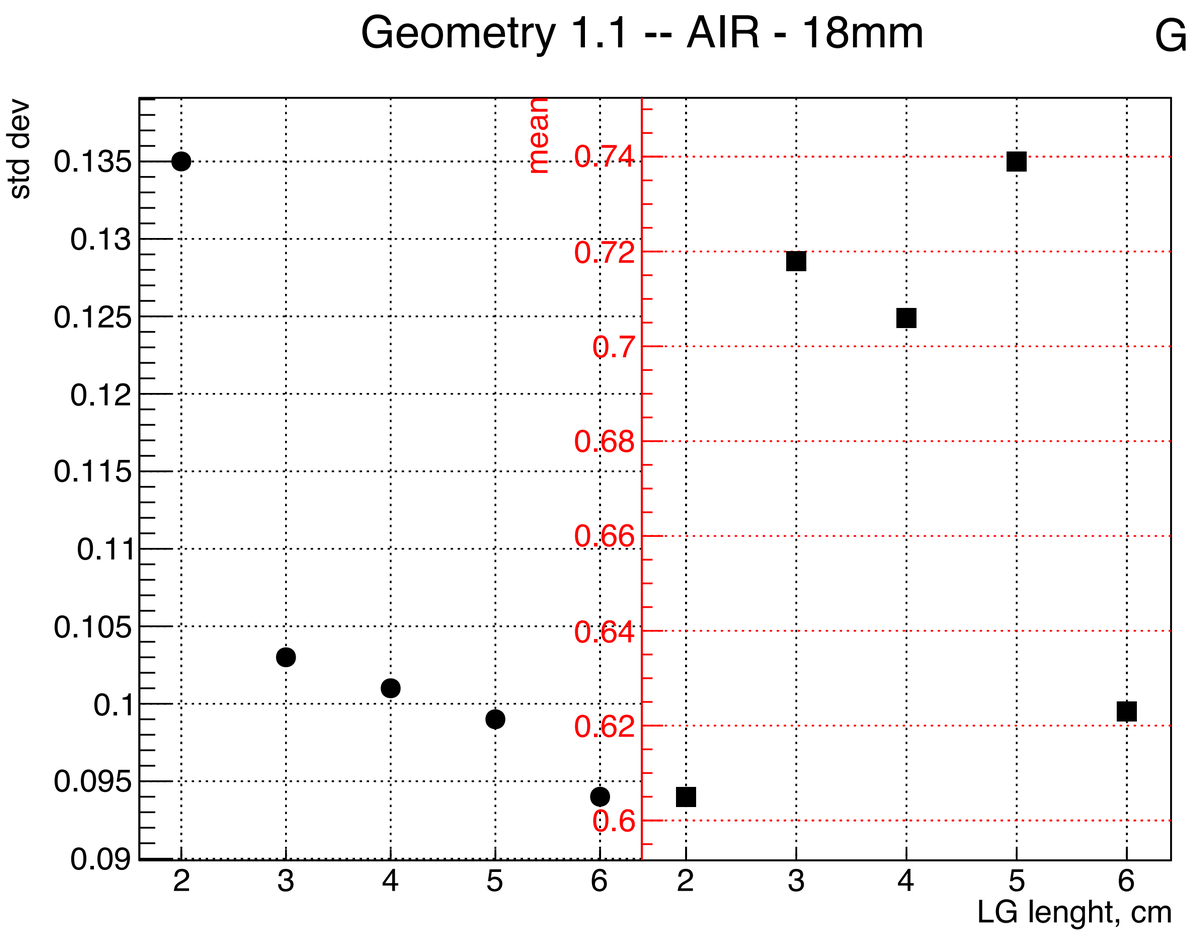

Geometry 4 -- PMMA - WC
Graph
std dev
mean
LG lenght, cm

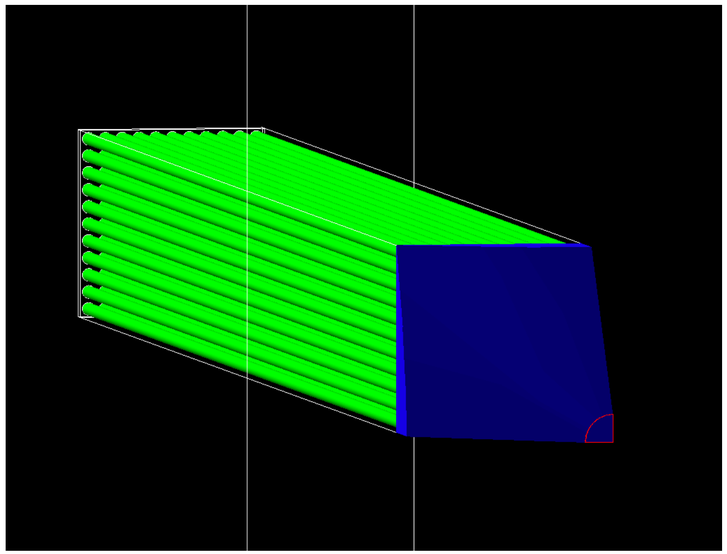

Geometry 6 -- AIR - 22x22
Graph
std dev
mean
LG lenght, cm


Geometry 1.1 -- AIR - 18mm
Grap
std dev
mean
LG lenght, cm


Geometry 4 -- AIR - WC
Graph
std dev
mean
LG lenght, cm

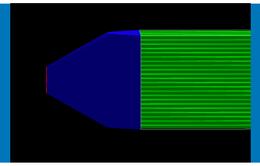

Geometry 1.1 -- PMMA - 18mm
std dev
mean
LG lenght, cm


Geometry 1.1 -- AIR - 18mm
std dev
mean
LG lenght, cm



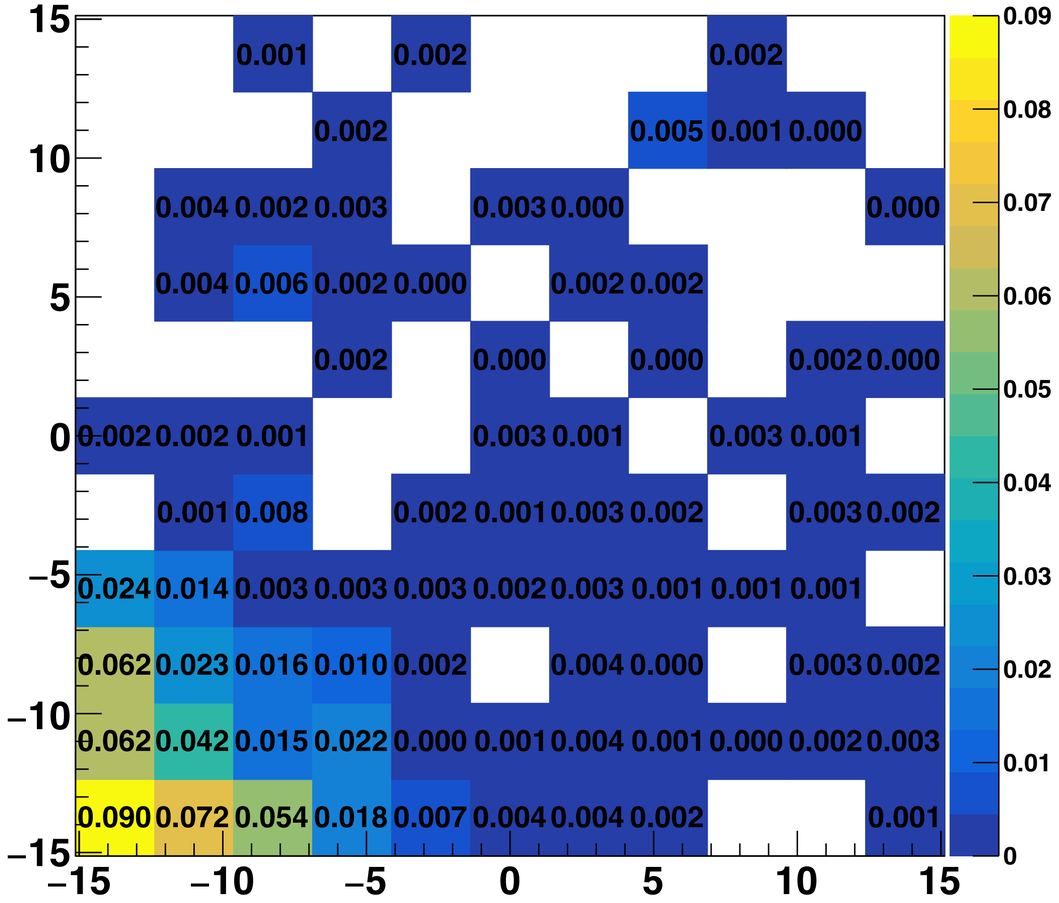
- **Geometry 7** **11x11 — FISH TAIL — 4.5 mm**

PMTRad = 4.5 mm

• Geometry7 PMMA  statistic 11.000 - muon 1 GeV

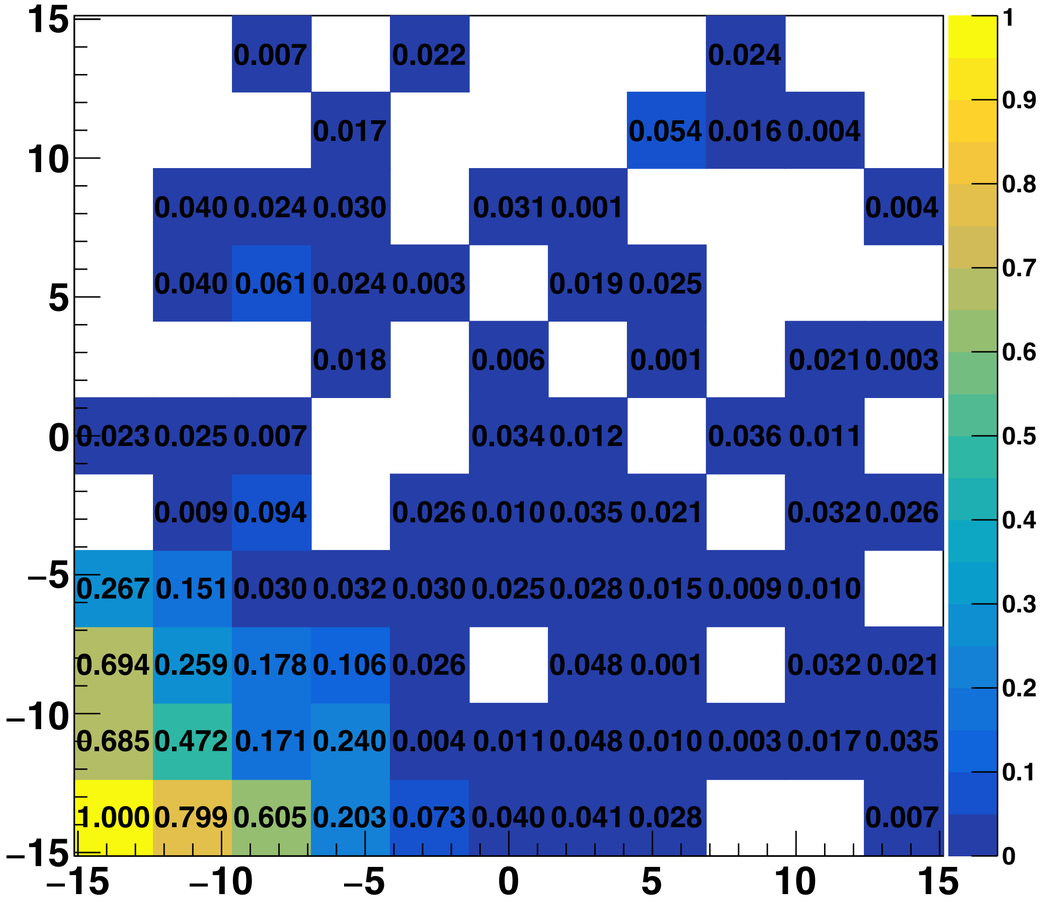
FISH TAIL
PMT 4.5

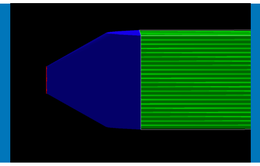
Efficiency - LG - PMMA - 2cm - base round - 4.5 mm



Factor non-uniformity - LG - PMMA - 2cm - base round - 4.5 mm

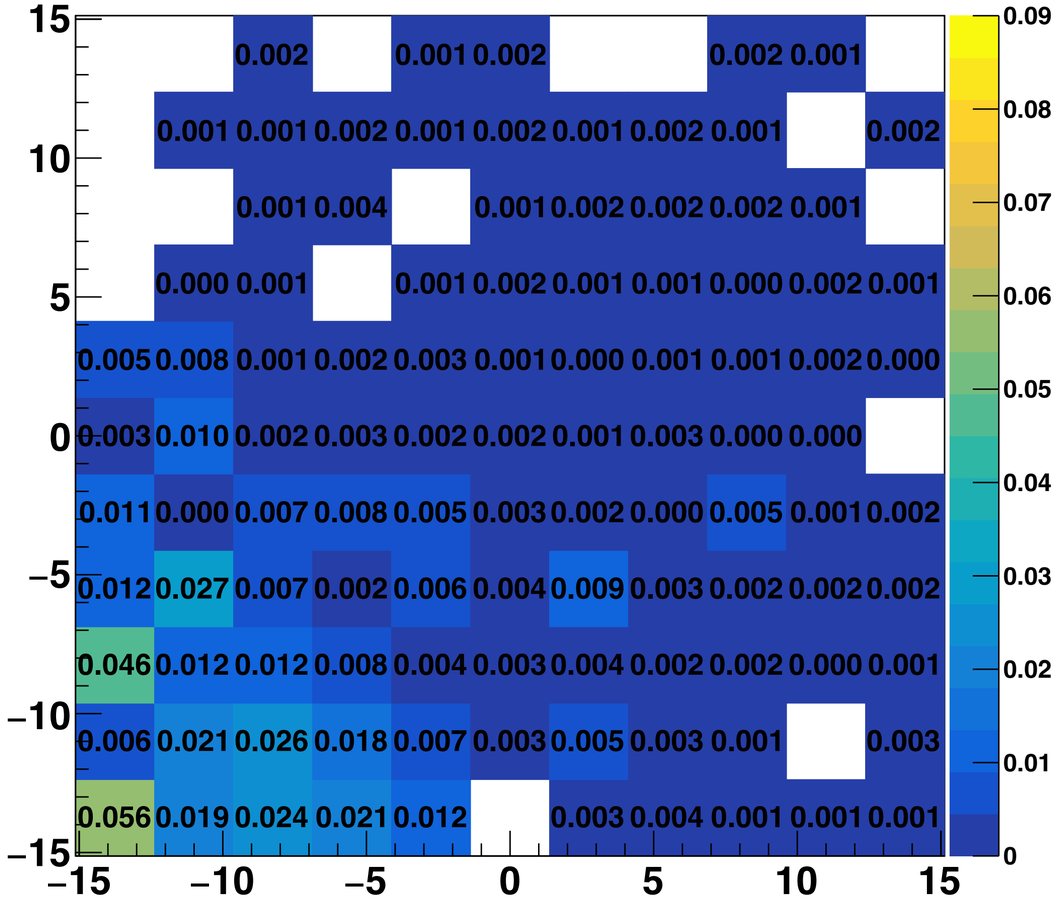
Standard deviation: 0.192 **Mean value: 0.094**



• Geometry7 PMMA  statistic 11.000 - muon 1 GeV

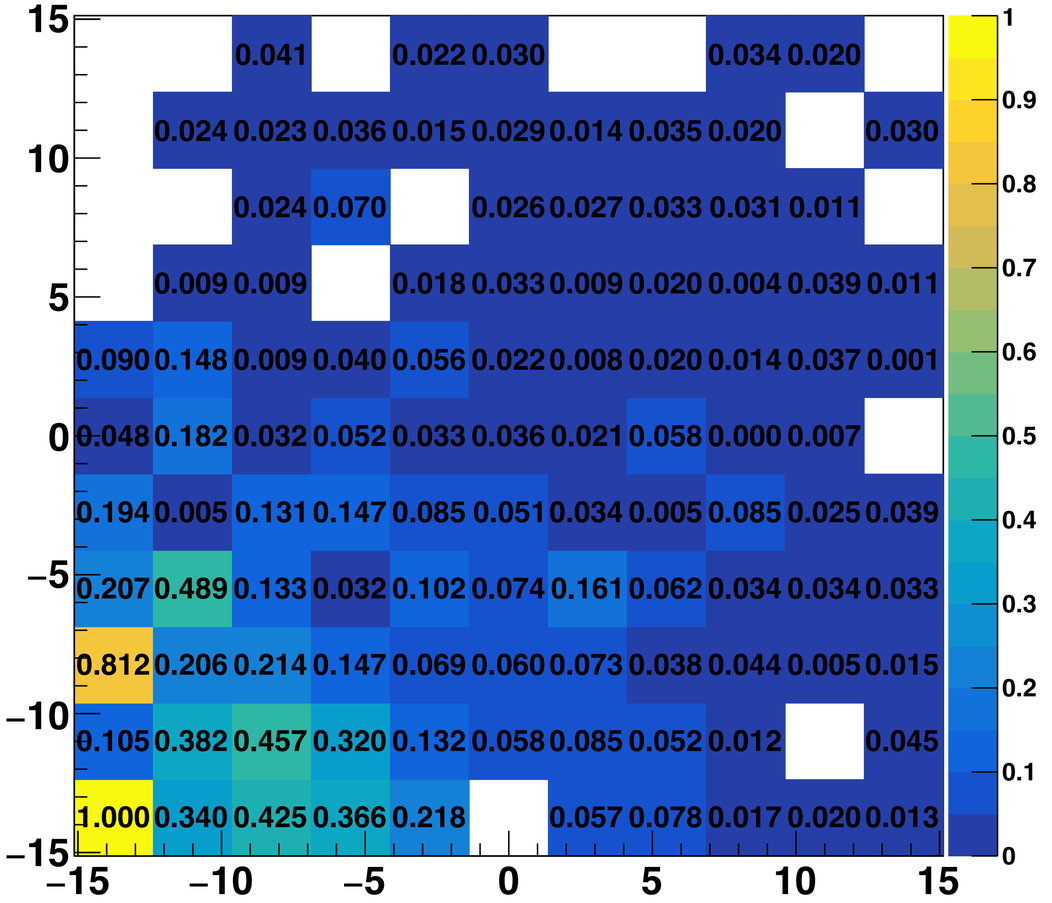
FISH TAIL
PMT 4.5

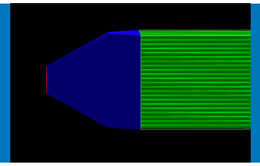
Efficiency - LG - PMMA - 3cm - base round - 4.5 mm



Factor non-uniformity - LG - PMMA - 3cm - base round - 4.5 mm

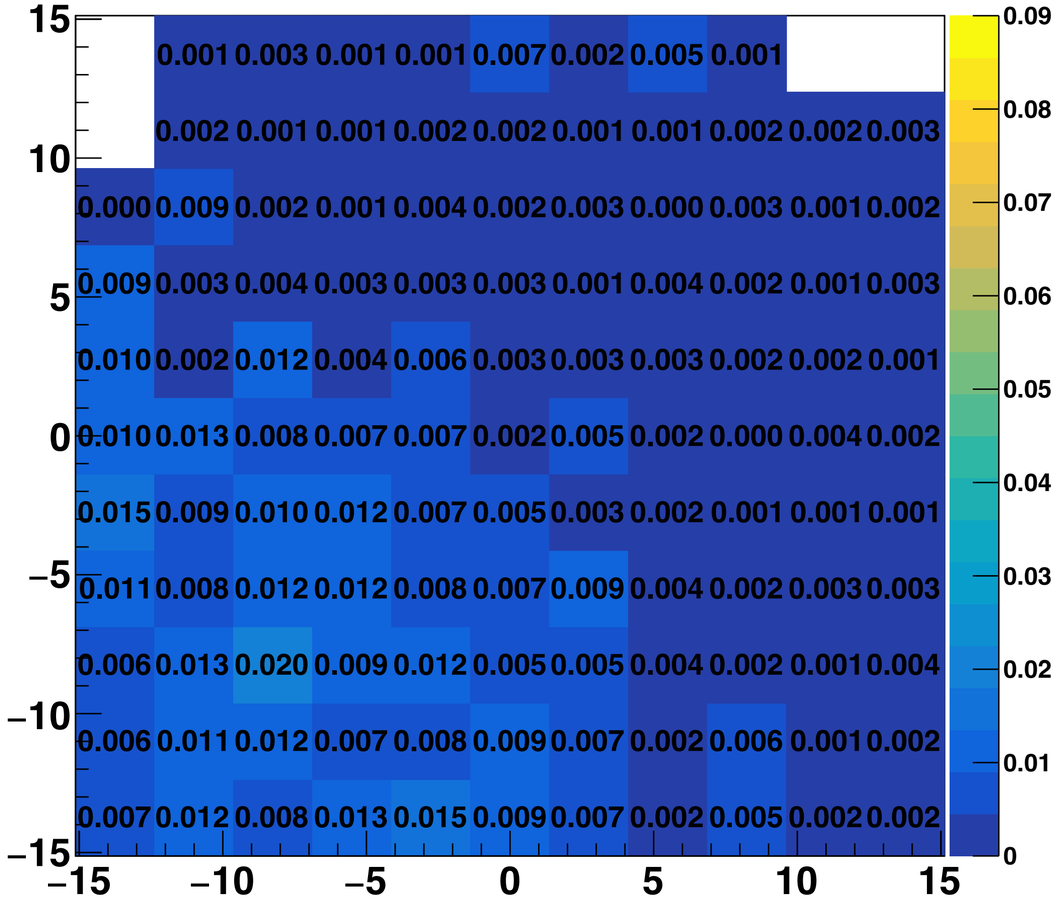
Standard deviation: 0.153 **Mean value: 0.093**



• Geometry7 PMMA  statistic 11.000 - muon 1 GeV

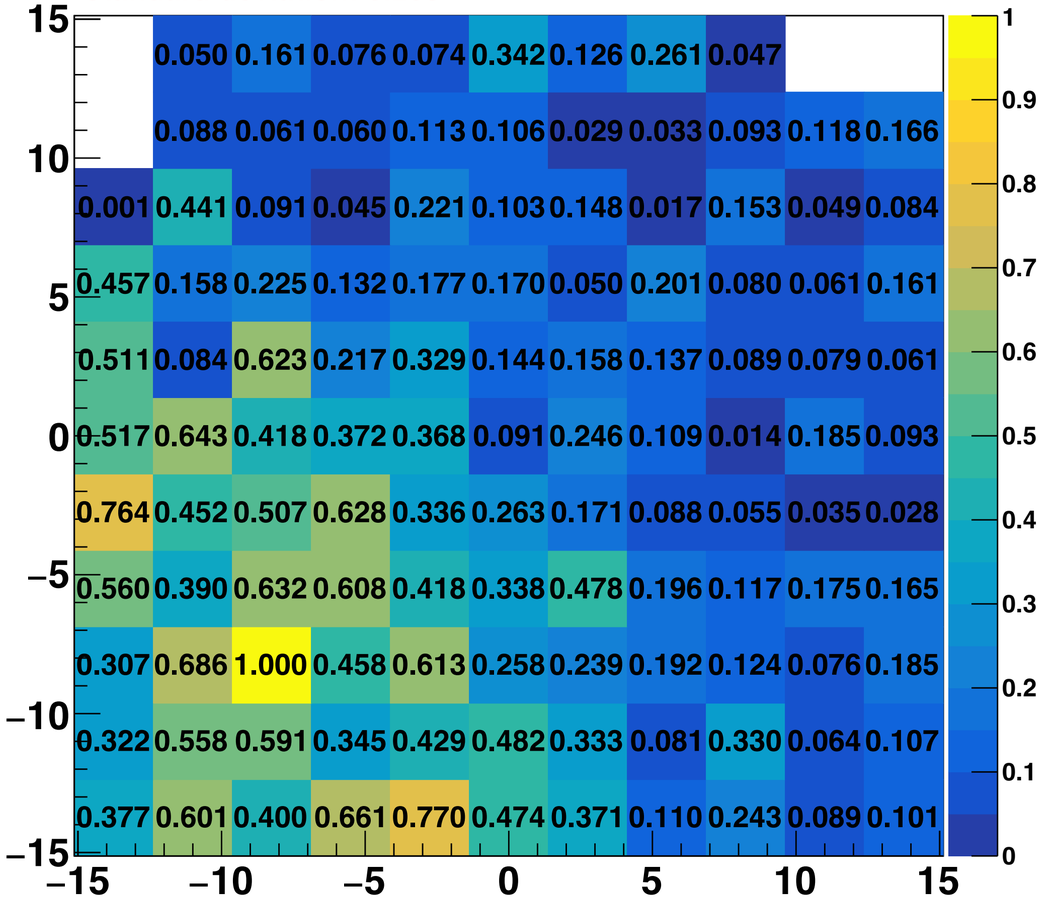
FISH TAIL
PMT 4.5

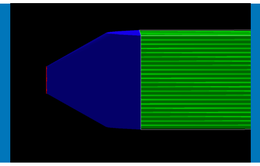
Efficiency - LG - PMMA - 4cm - base round - 4.5 mm



Factor non-uniformity - LG - PMMA - 4cm - base round - 4.5 mm

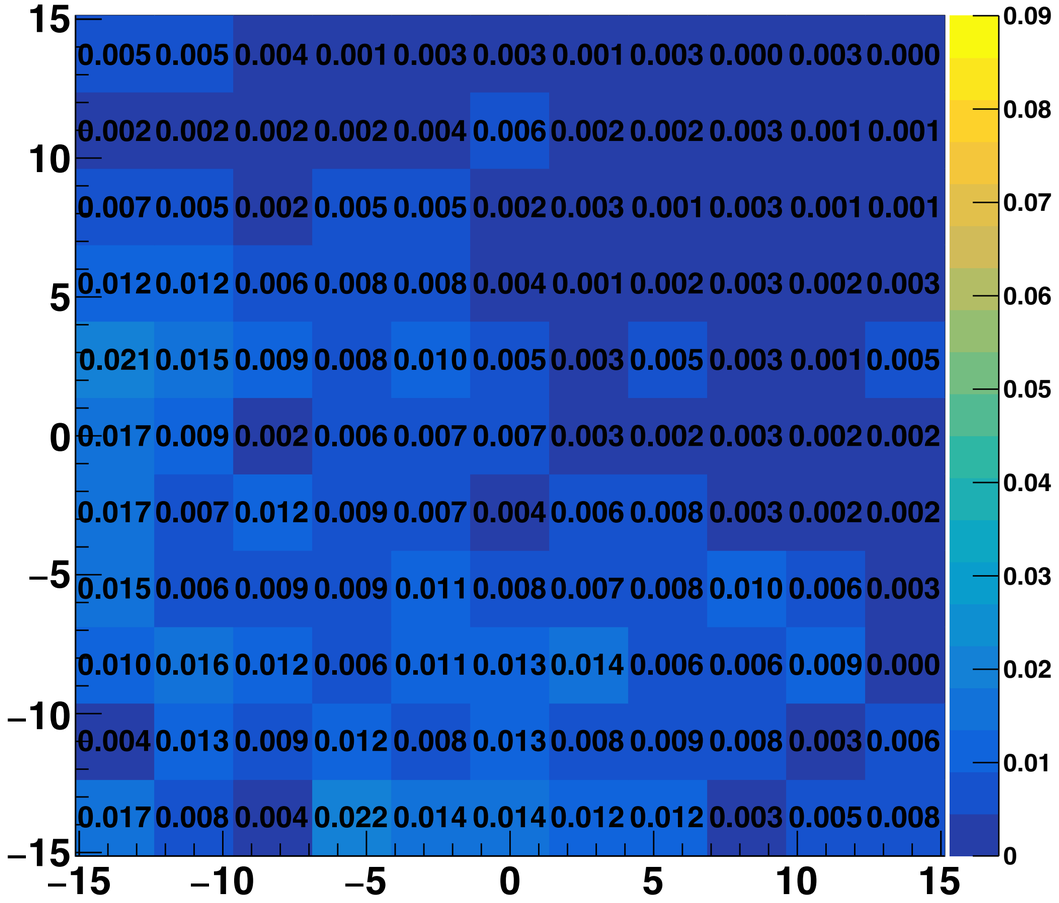
Standard deviation: 0.208 **Mean value: 0.257**



• Geometry7 PMMA  statistic 11.000 - muon 1 GeV

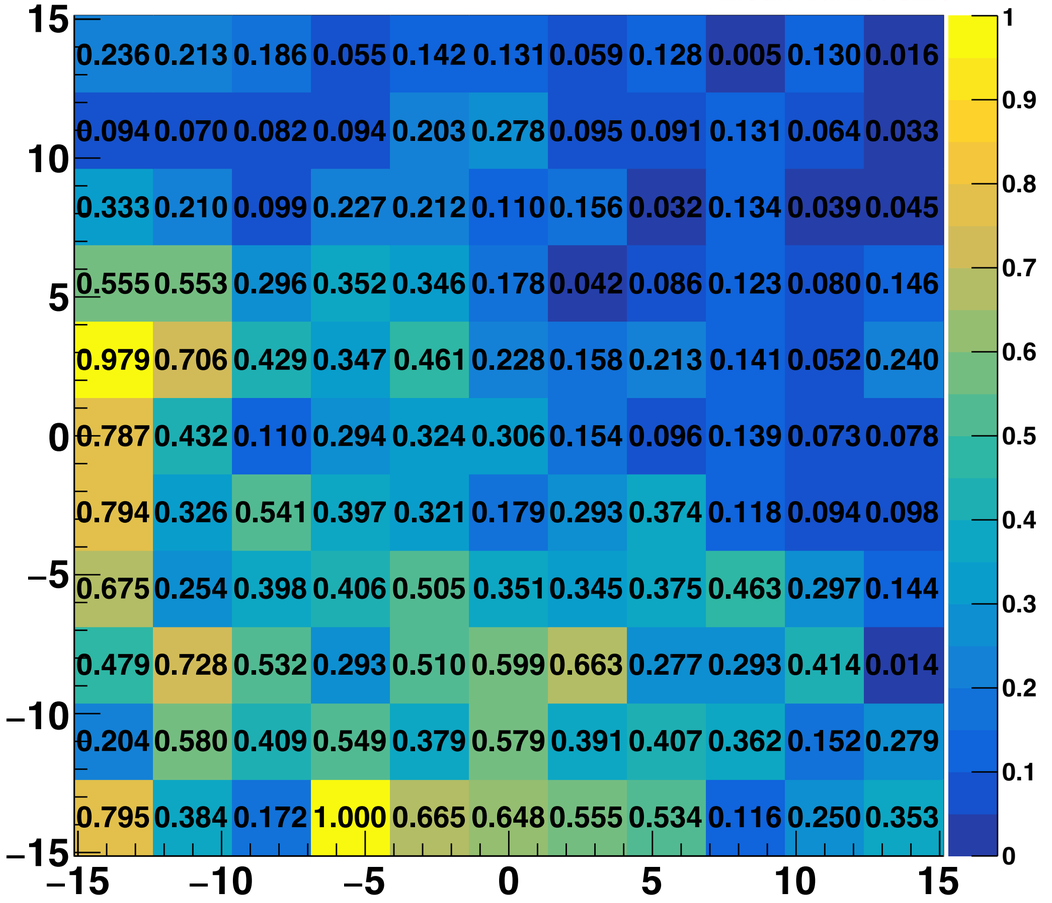
FISH TAIL
PMT 4.5

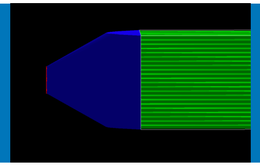
Efficiency - LG - PMMA - 5cm - base round - 4.5 mm



Factor non-uniformity - LG - PMMA - 5cm - base round - 4.5 mm

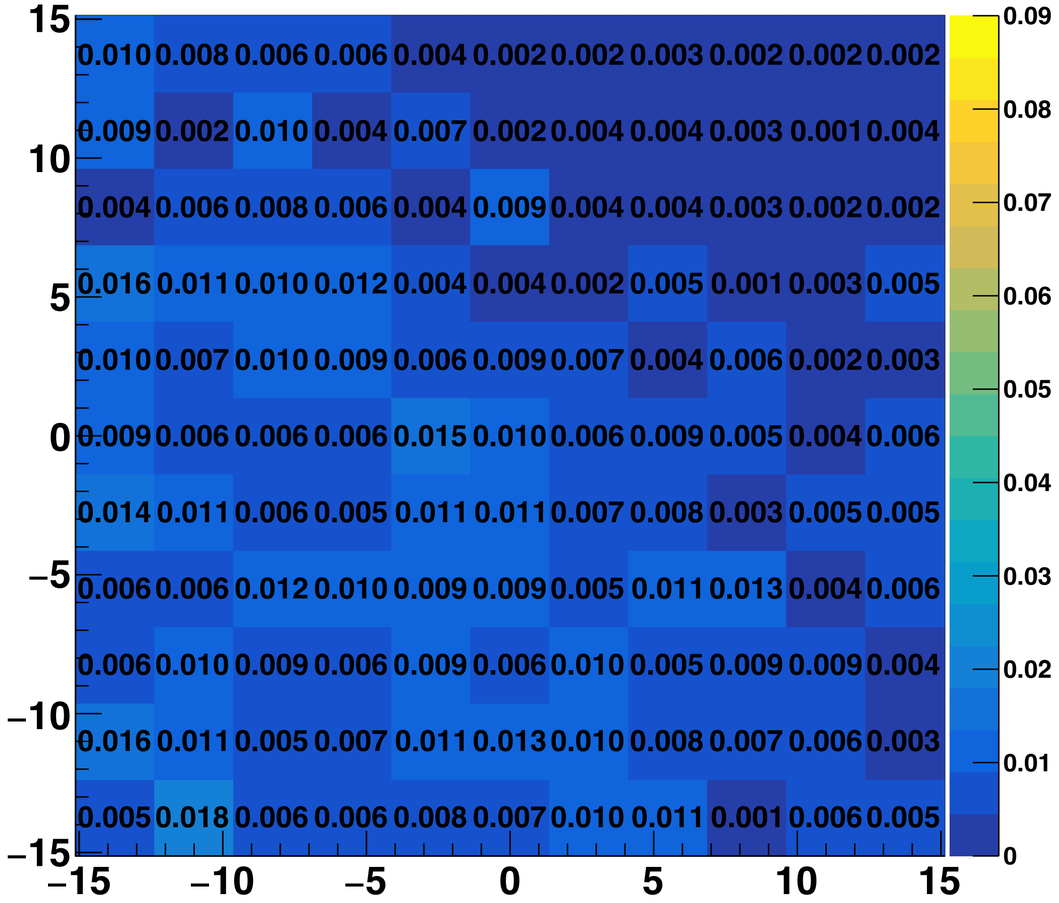
Standard deviation: 0.216 **Mean value: 0.297**



• Geometry7 PMMA  statistic 11.000 - muon 1 GeV

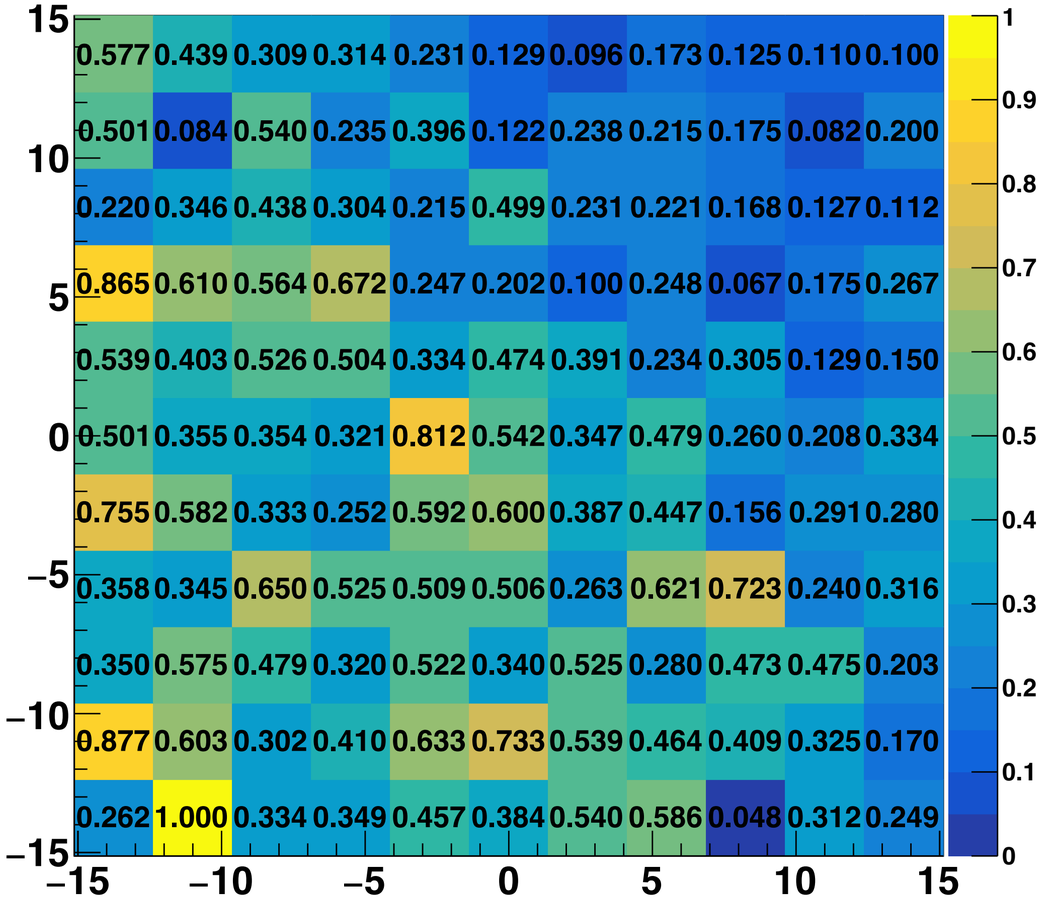
FISH TAIL
PMT 4.5

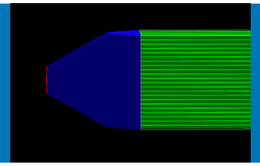
Efficiency - LG - PMMA - 6cm - base round - 4.5 mm



Factor non-uniformity - LG - PMMA - 6cm - base round - 4.5 mm

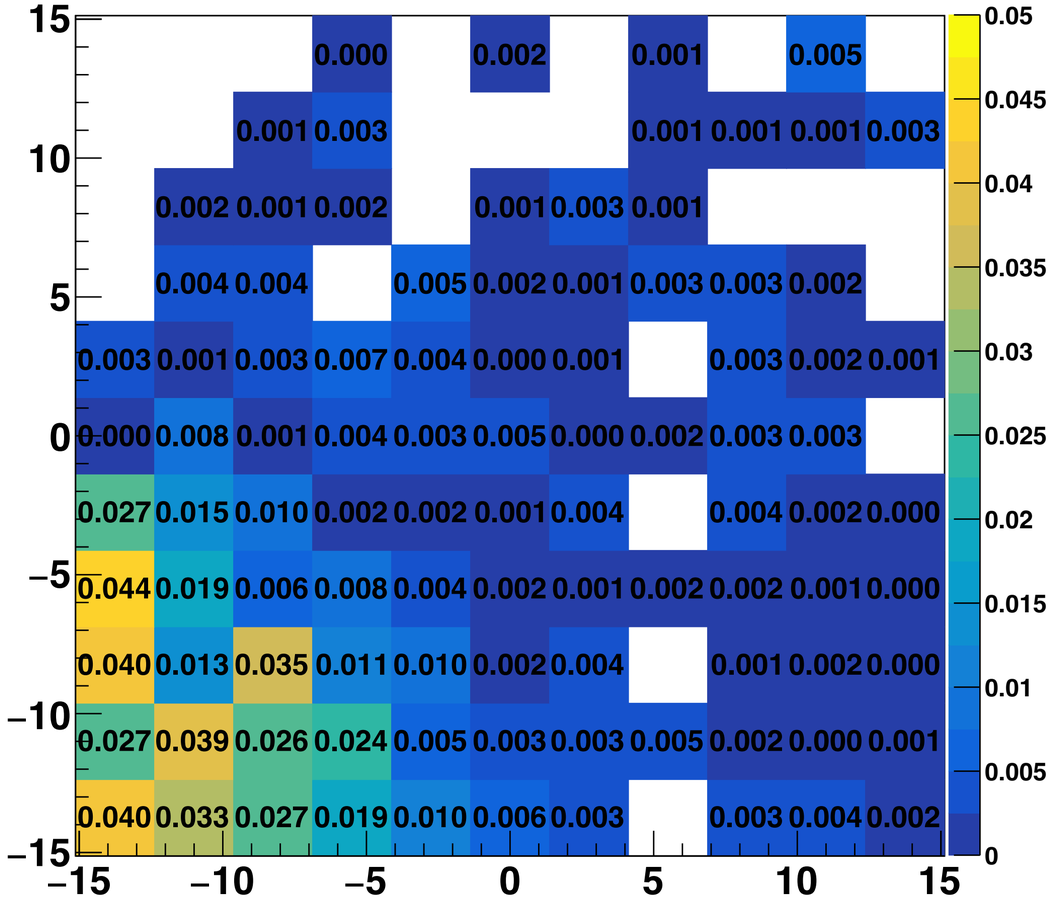
Standard deviation: 0.192 **Mean value: 0.372**



• Geometry7 AIR  statistic 11.000 - muon 1 GeV

FISH TAIL
PMT 4.5

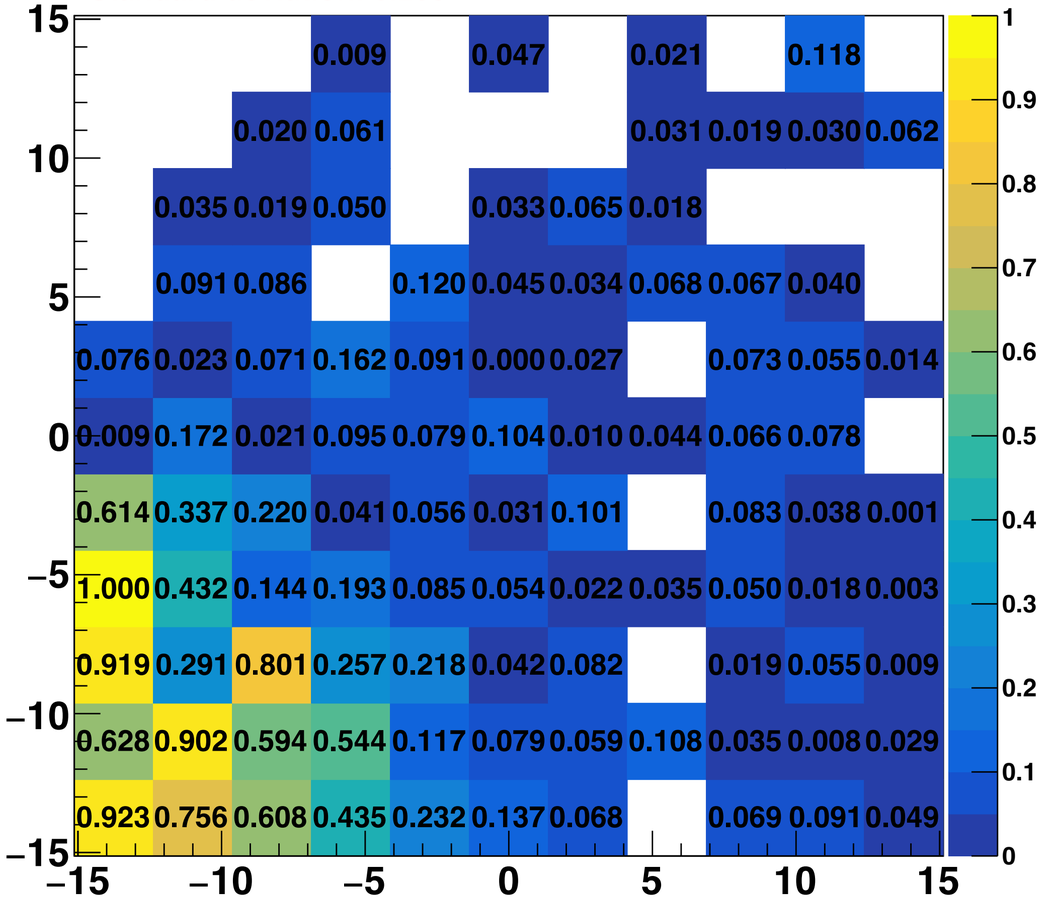
Efficiency - LG - Air - 2cm - base round - 4.5 mm



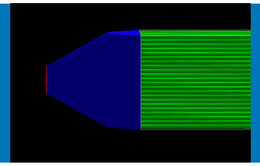
Factor non-uniformity - LG - Air - 2cm - base round - 4.5 mm

Standard deviation: 0.235

Mean value: 0.158



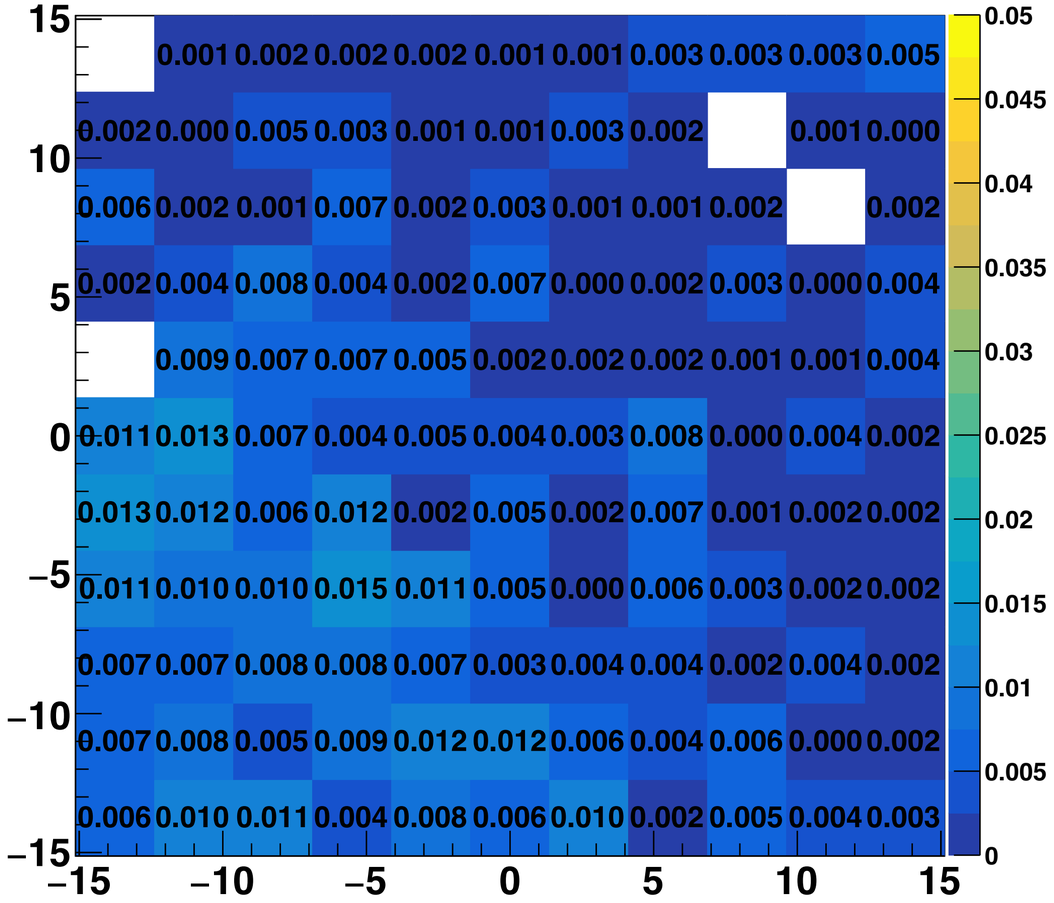
- **Geometry7** AIR



statistic 11.000 - muon 1 GeV

FISH TAIL
PMT 4.5

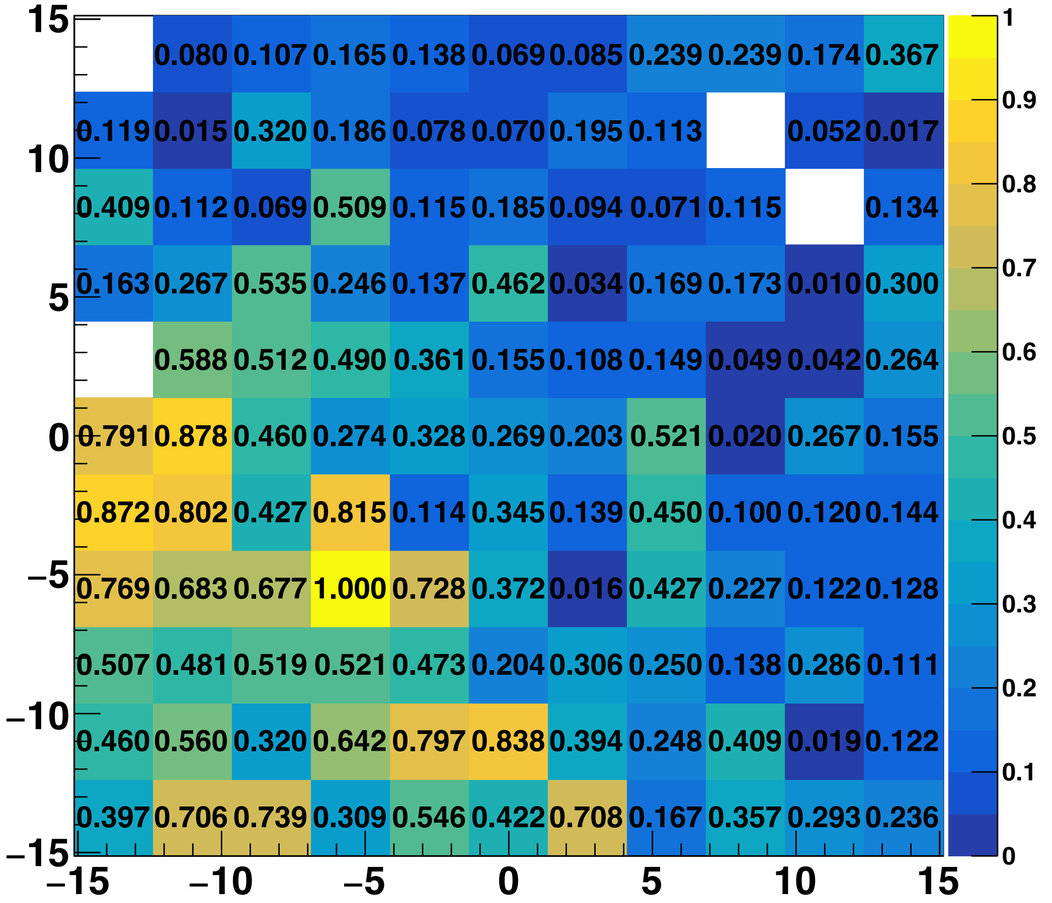
Efficiency - LG - Air - 3cm - base round - 4.5 mm

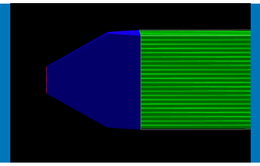


Factor non-uniformity - LG - Air - 3cm - base round - 4.5 mm

Standard deviation: 0.238

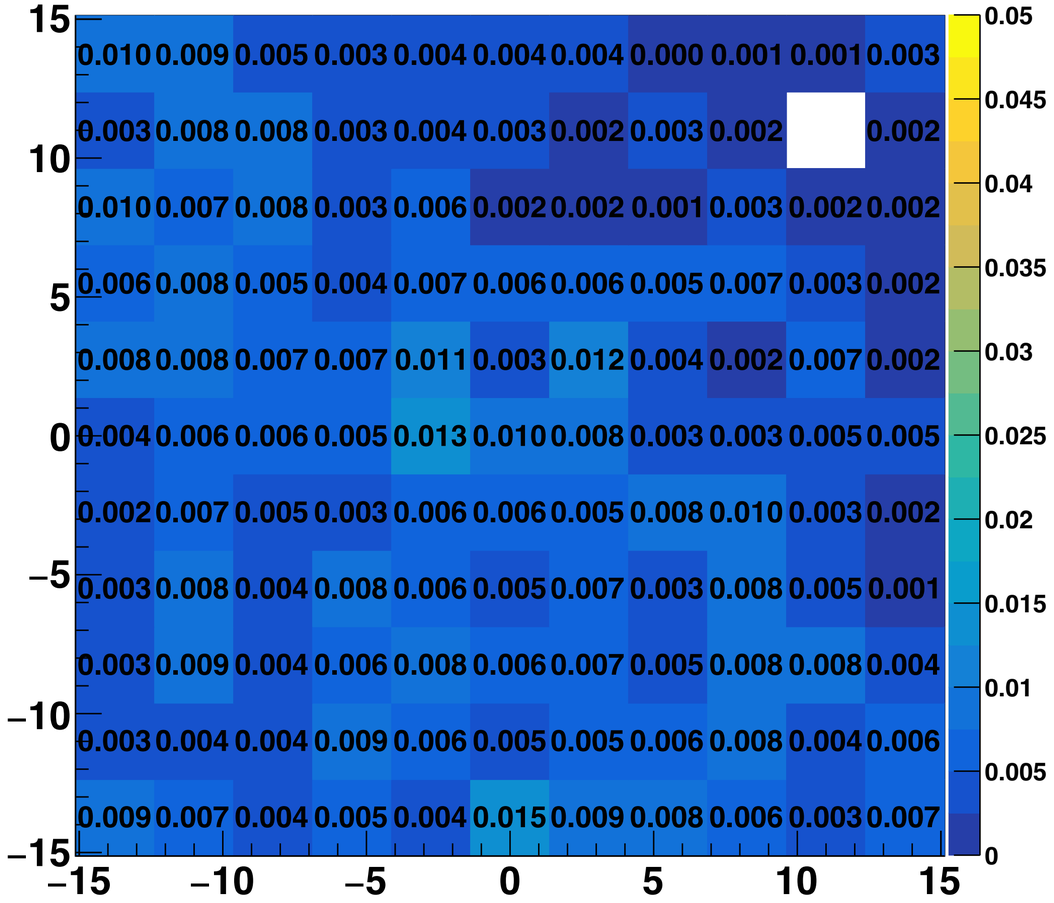
Mean value: 0.316



• Geometry7 AIR  statistic 11.000 - muon 1 GeV

FISH TAIL
PMT 4.5

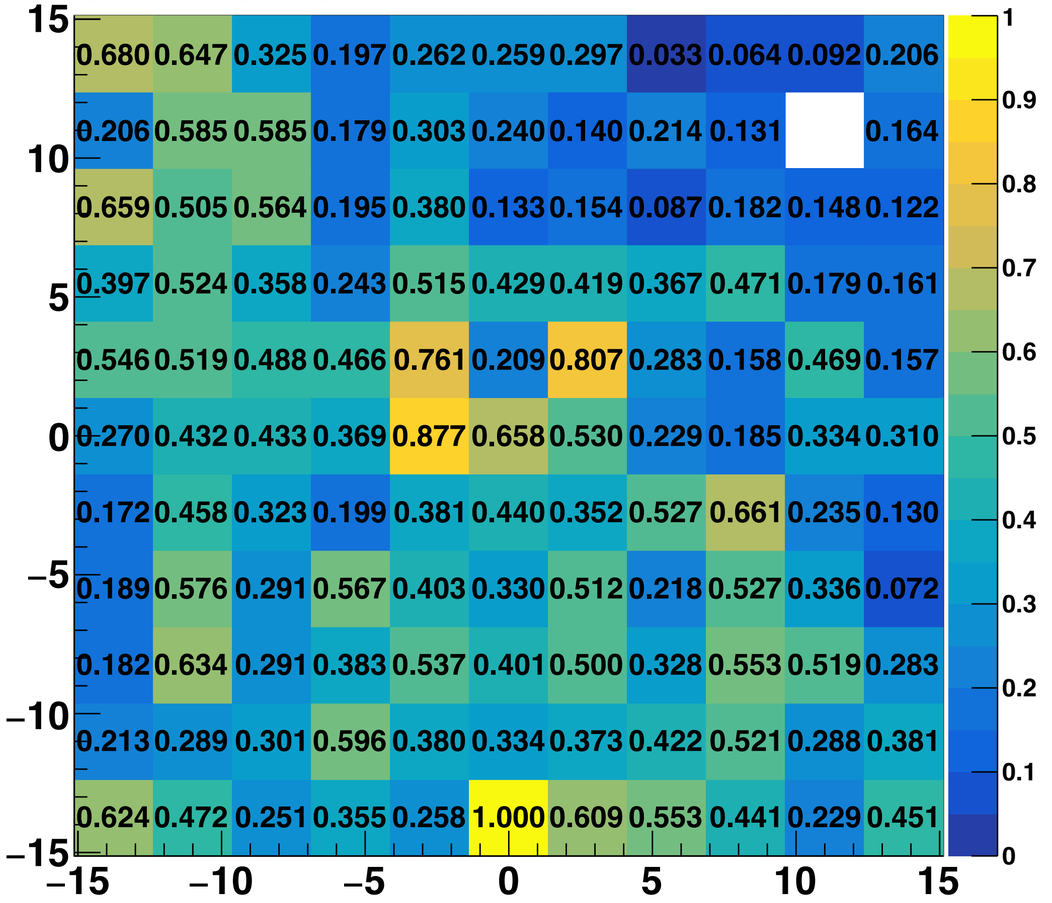
Efficiency - LG - Air - 4cm - base round - 4.5 mm

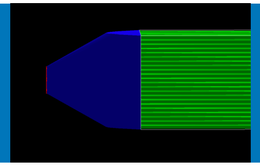


Factor non-uniformity - LG - Air - 4cm - base round - 4.5 mm

Standard deviation: 0.184

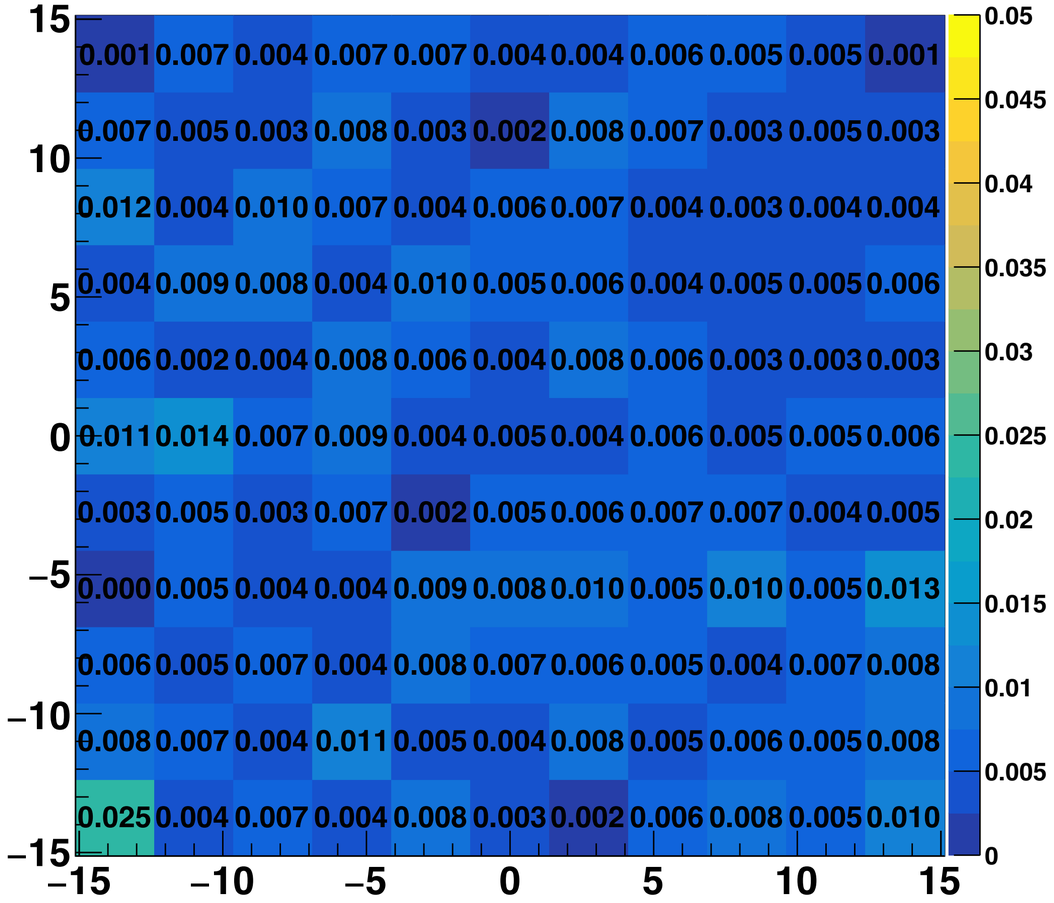
Mean value: 0.369



• Geometry7 AIR  statistic 11.000 - muon 1 GeV

FISH TAIL
PMT 4.5

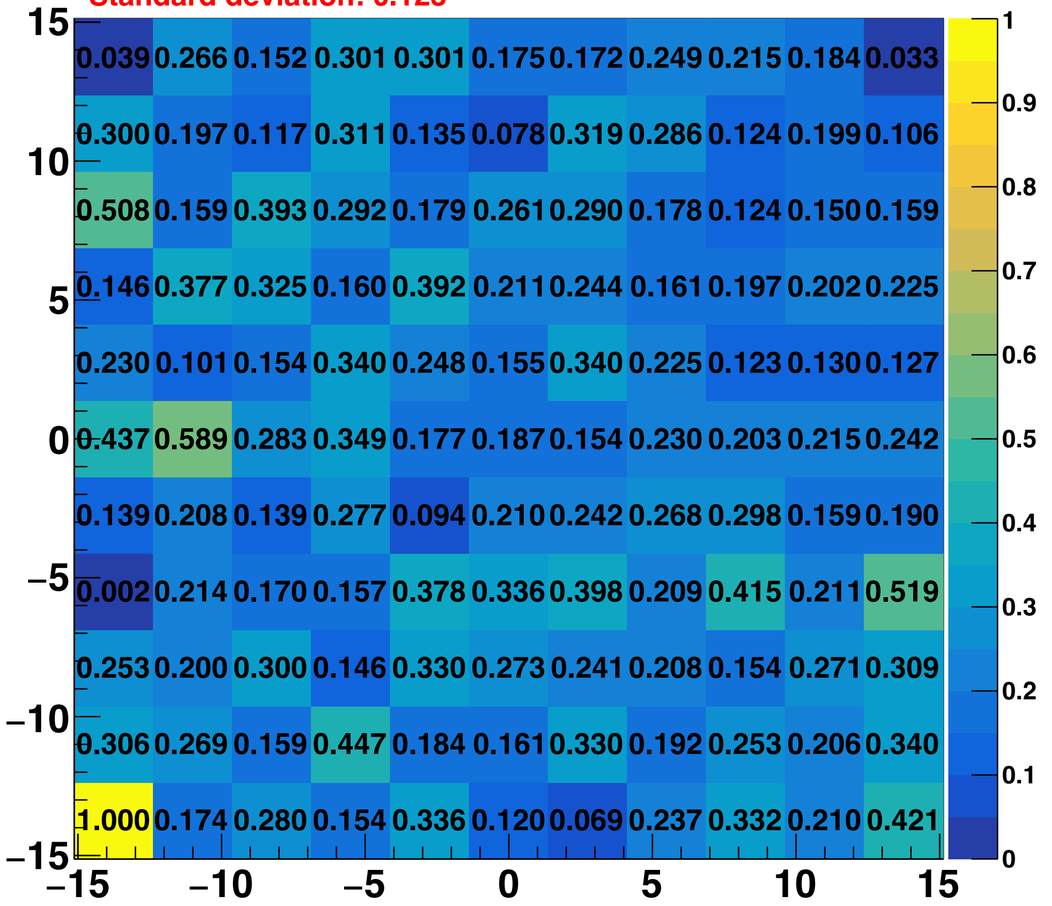
Efficiency - LG - Air - 5cm - base round - 4.5 mm

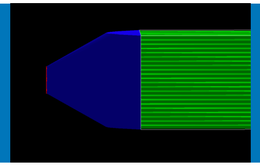


Factor non-uniformity - LG - Air - 5cm - base round - 4.5 mm

Standard deviation: 0.123

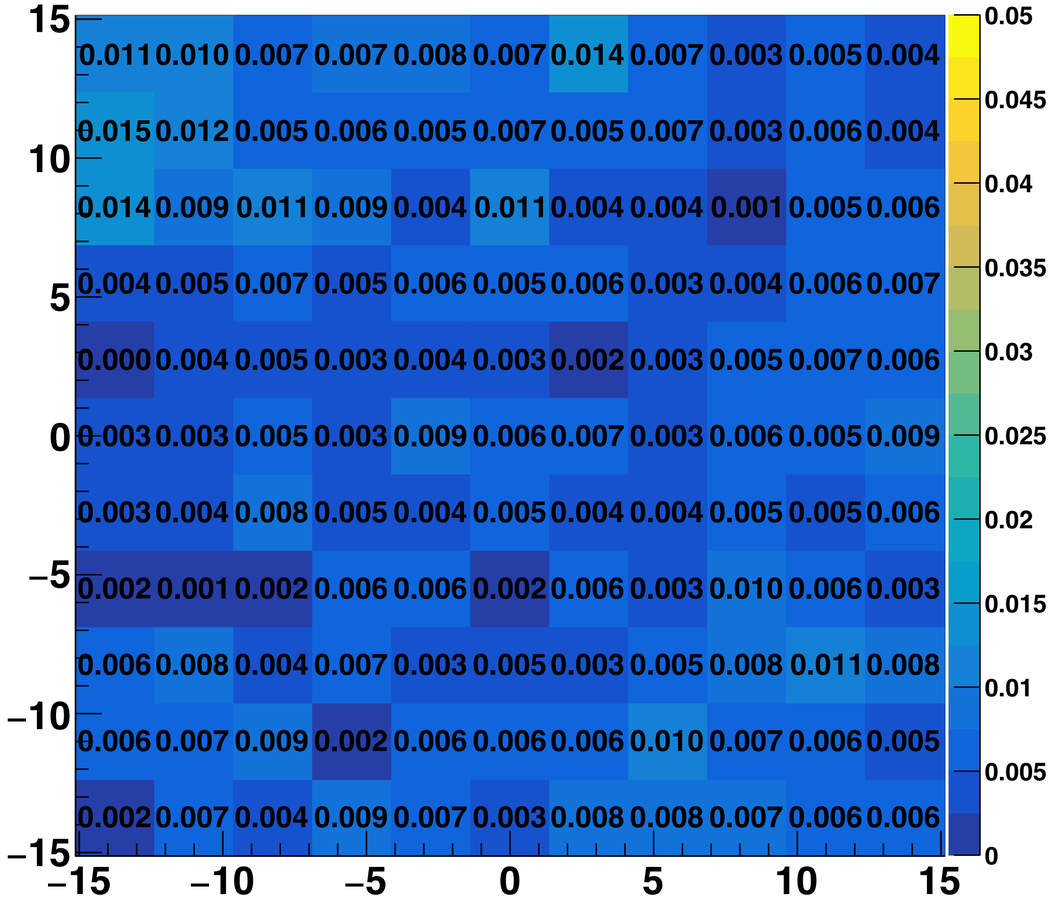
Mean value: 0.239



• Geometry7 AIR  statistic 11.000 - muon 1 GeV

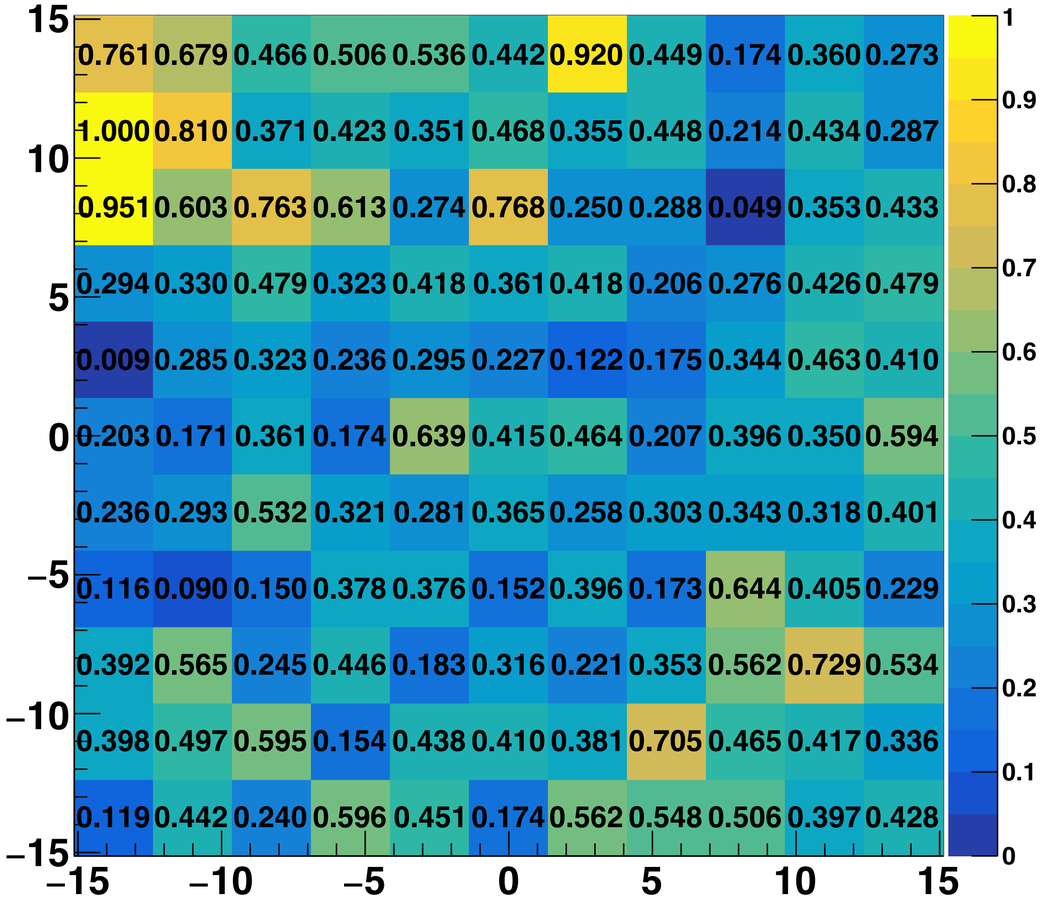
FISH TAIL
PMT 4.5

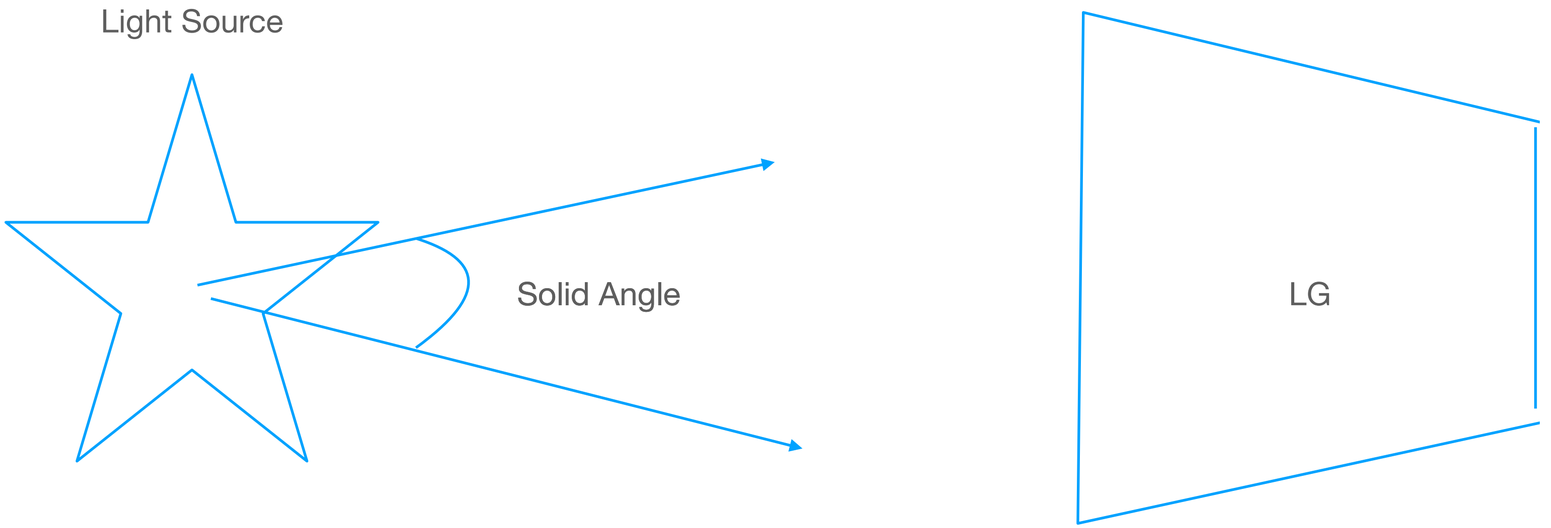
Efficiency - LG - Air - 6cm - base round - 4.5 mm



Factor non-uniformity - LG - Air - 6cm - base round - 4.5 mm

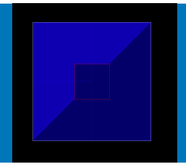
Standard deviation: 0.184 **Mean value: 0.393**



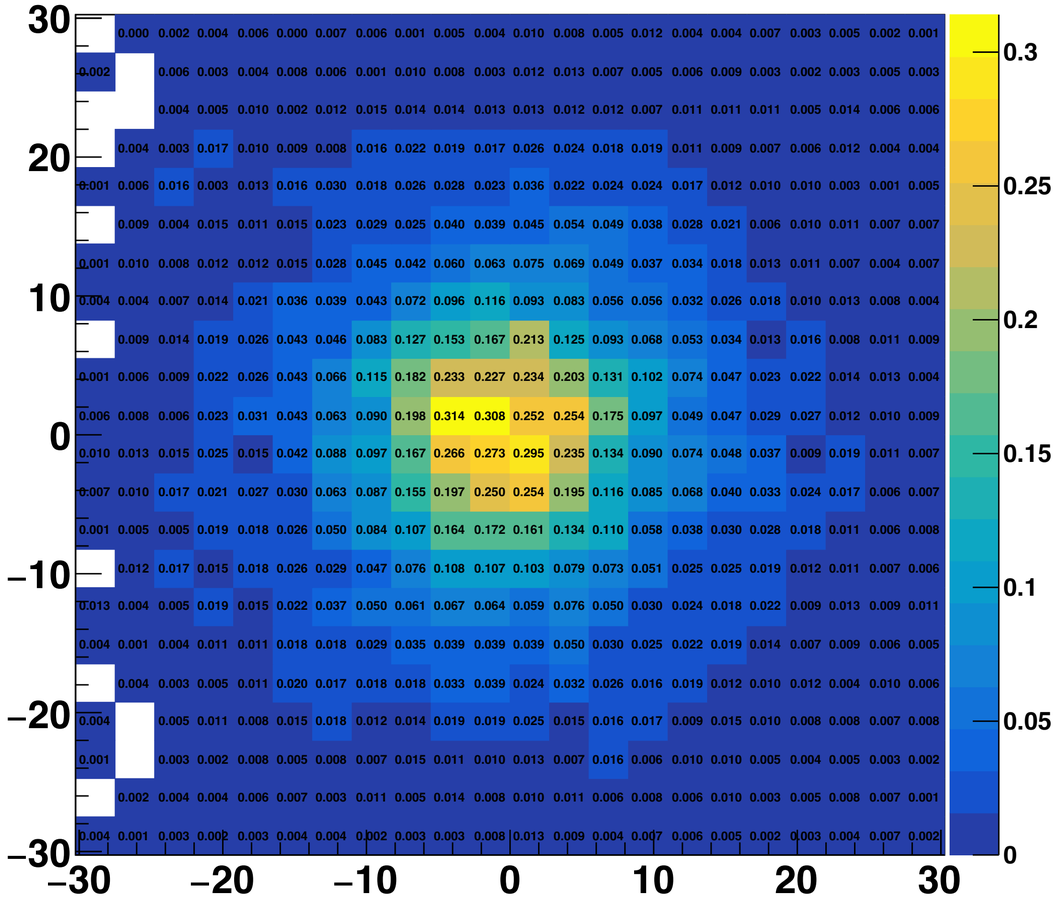


VARY?

OLD

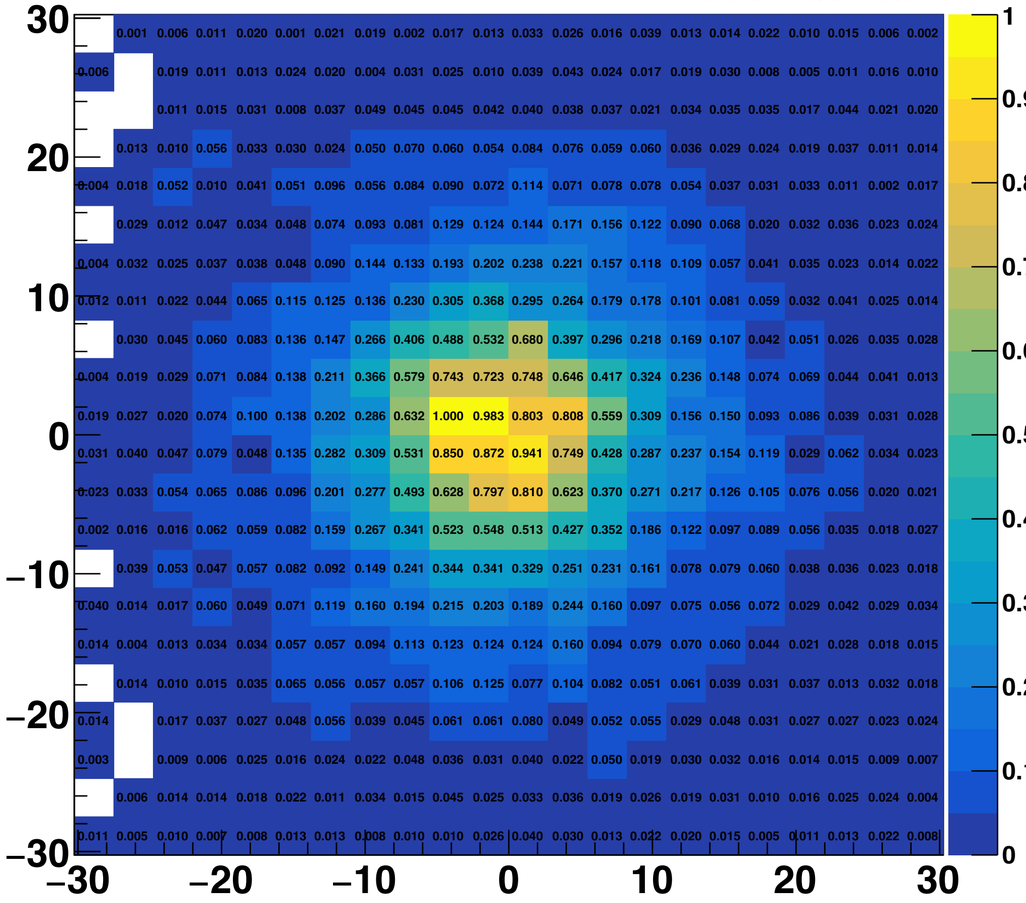
• Geometry 6 PMMA  22x22 — Trap — 18 mm

Efficiency - LG - PMMA - 2cm - 22x22 - 18. mm

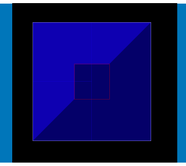


Factor non-uniformity - LG - PMMA - 2cm - 22x22 - 18. mm

Mean value: 0.109

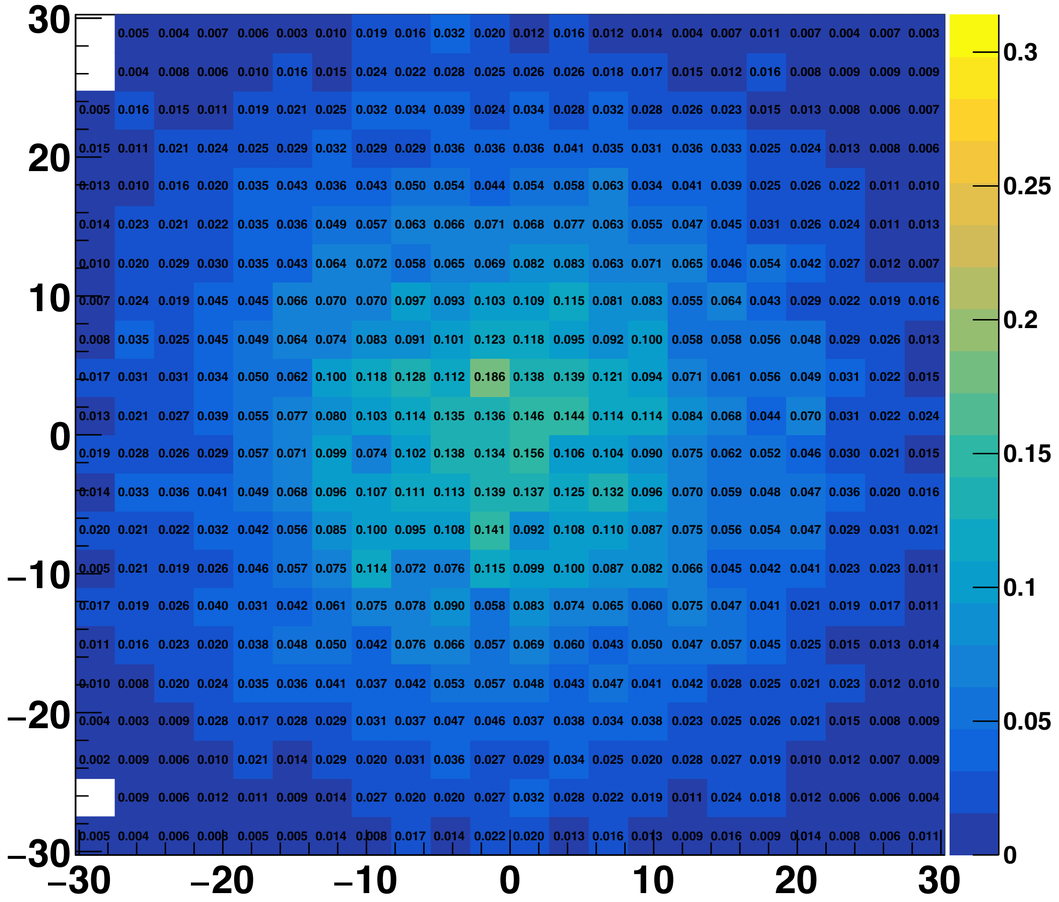


• Geometry 6 PMMA



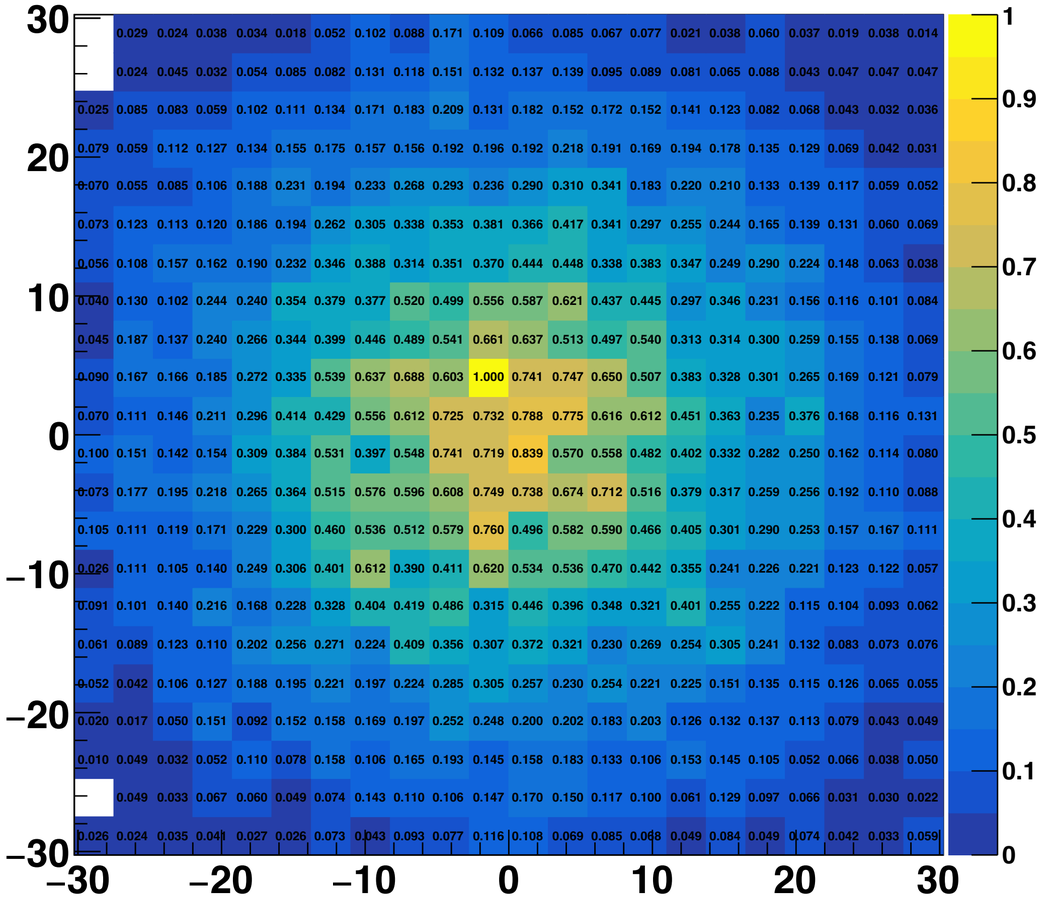
22x22 — Trap — 18 mm

Efficiency - LG - PMMA - 3cm - 22x22 - 18. mm

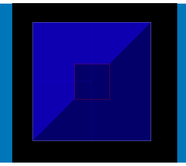


Factor non-uniformity - LG - PMMA - 3cm - 22x22 - 18. mm

Mean value: 0.227

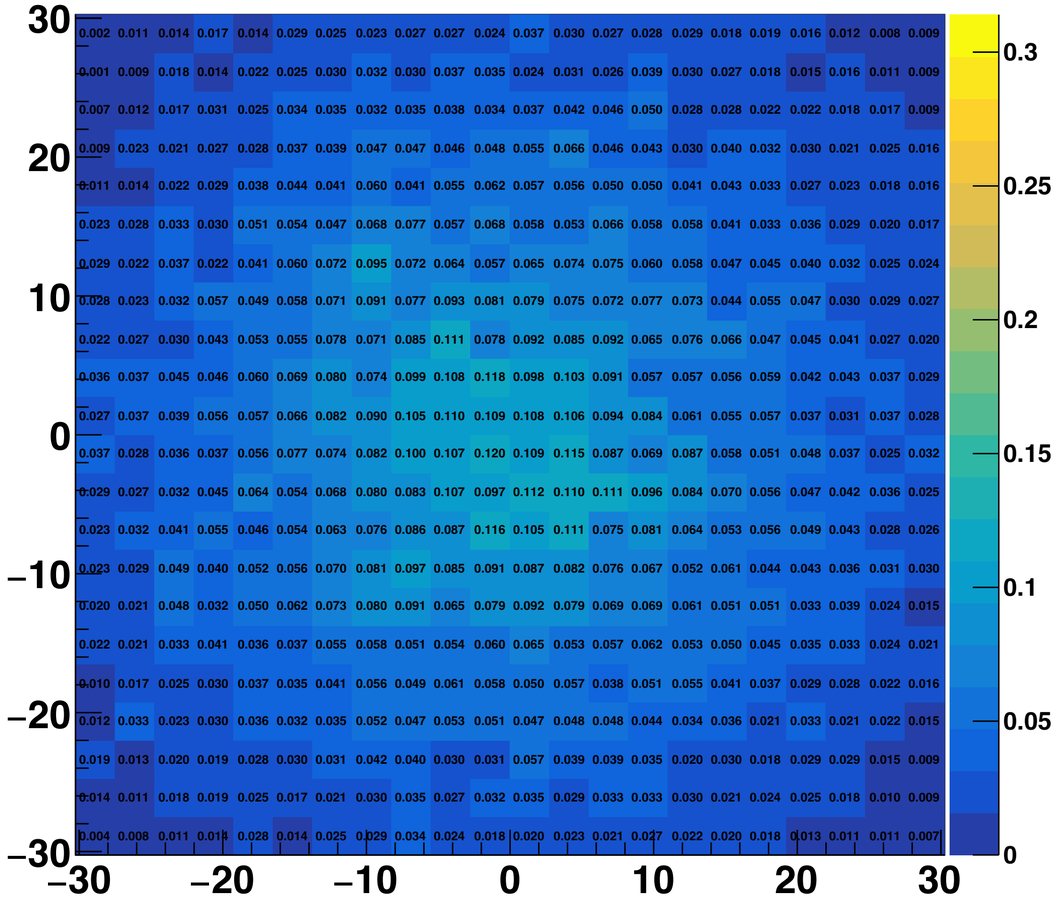


• Geometry 6 PMMA



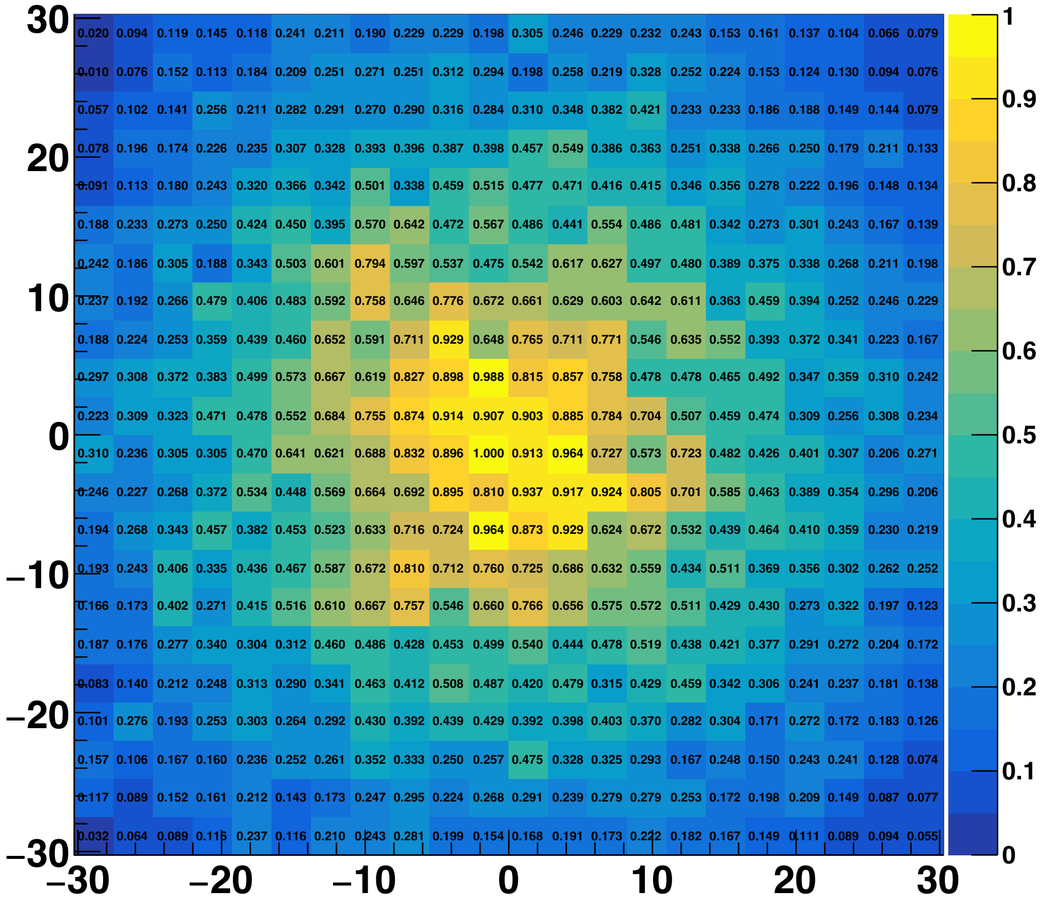
22x22 — Trap — 18 mm

Efficiency - LG - PMMA - 4cm - 22x22 - 18. mm

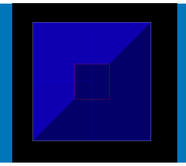


Factor non-uniformity - LG - PMMA - 4cm - 22x22 - 18. mm

Mean value: 0.375

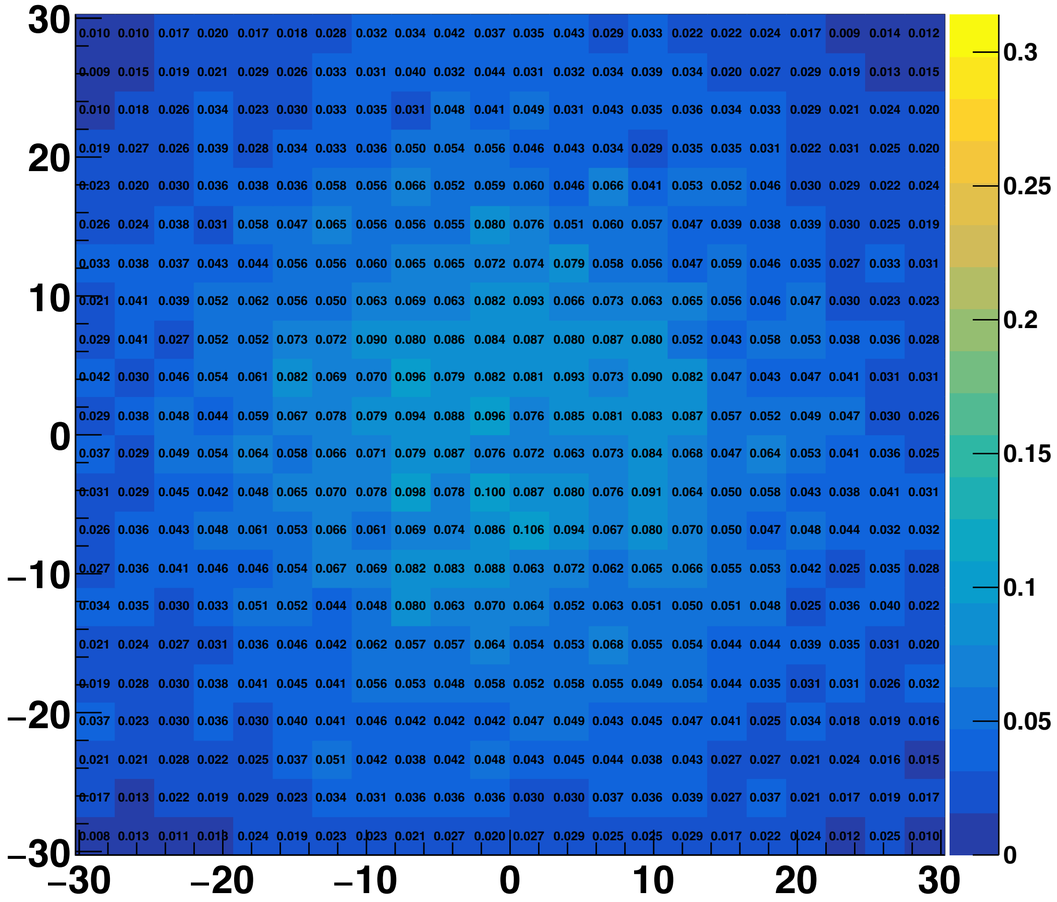


• Geometry 6 PMMA



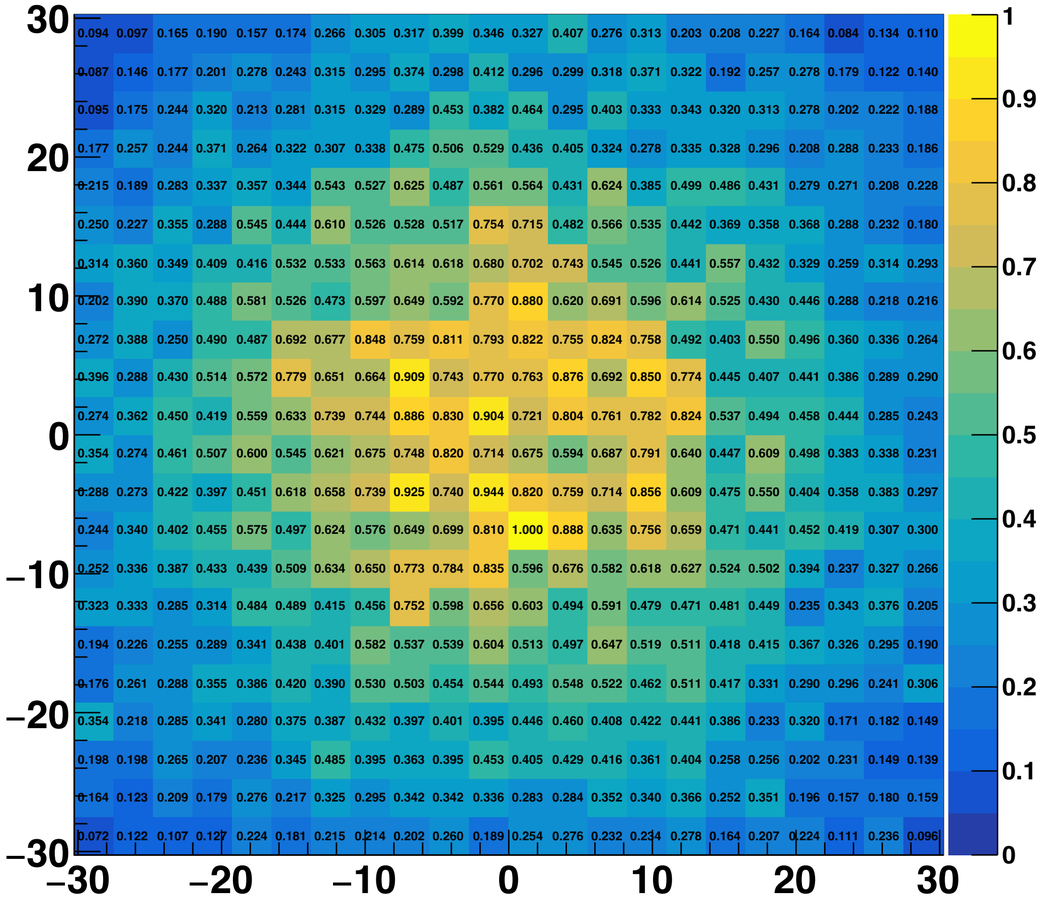
22x22 — Trap — 18 mm

Efficiency - LG - PMMA - 5cm - 22x22 - 18. mm

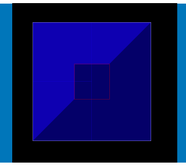


Factor non-uniformity - LG - PMMA - 5cm - 22x22 - 18. mm

Mean value: 0.420

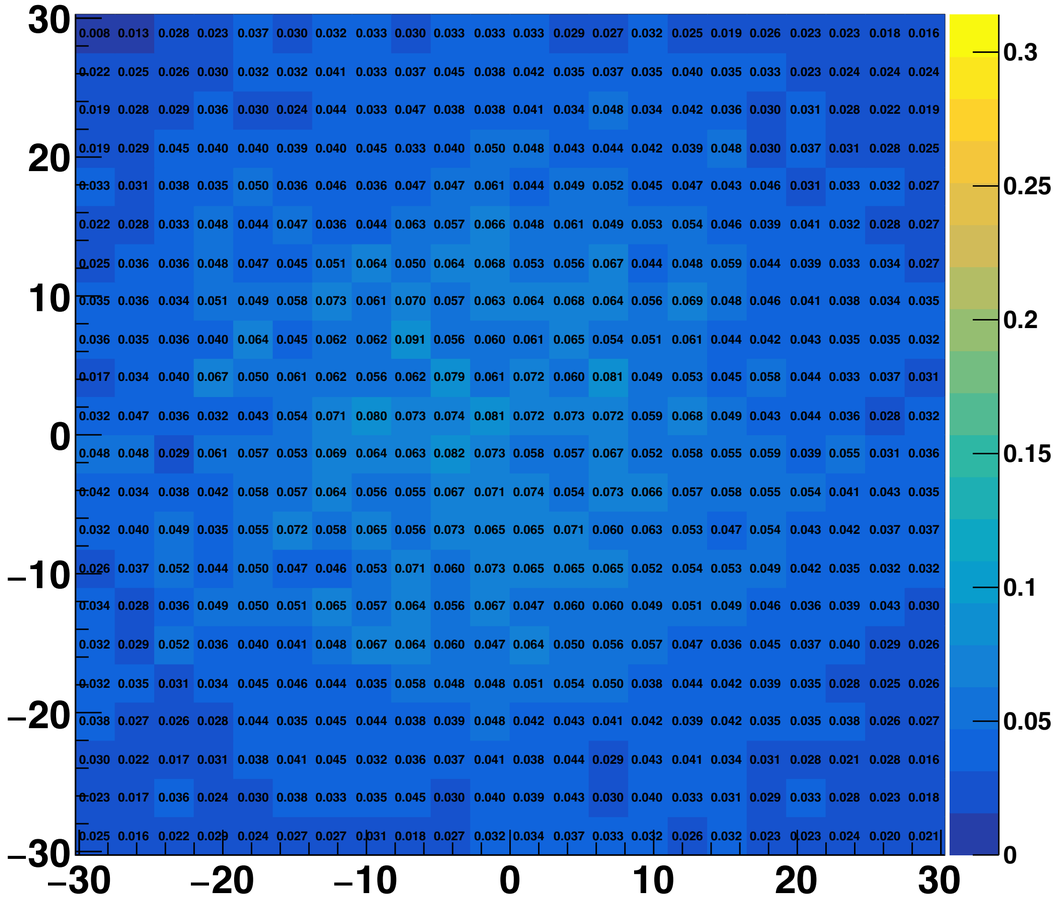


• Geometry 6 PMMA



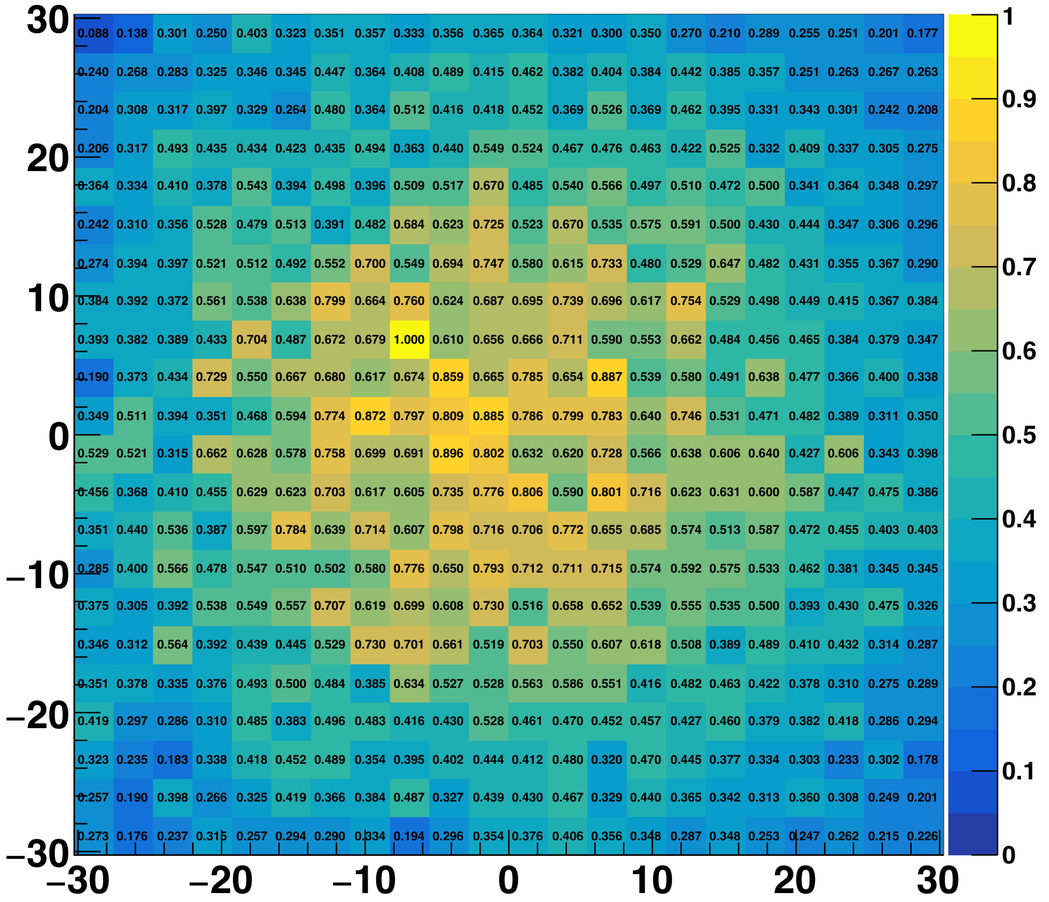
22x22 — Trap — 18 mm

Efficiency - LG - PMMA - 6cm - 22x22 - 18. mm

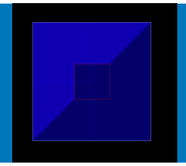


Factor non-uniformity - LG - PMMA - 6cm - 22x22 - 18. mm

Mean value: 0.471

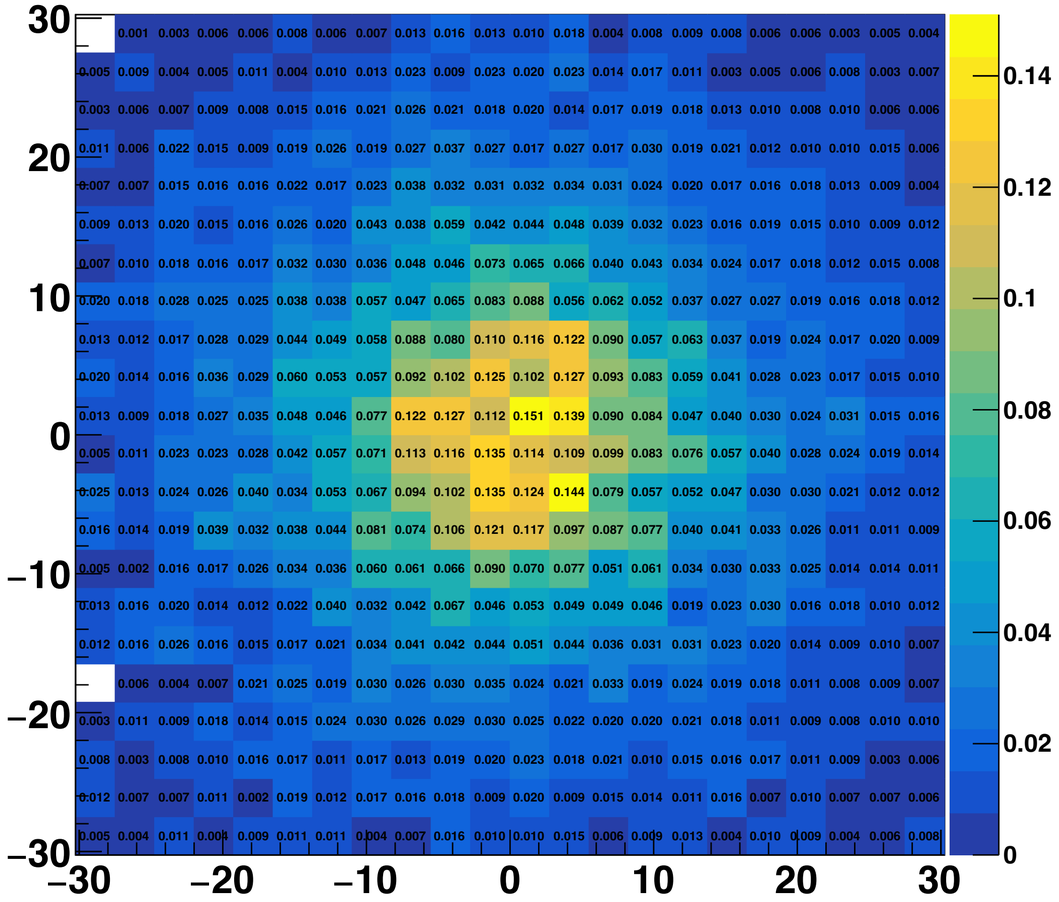


• Geometry 6 AIR



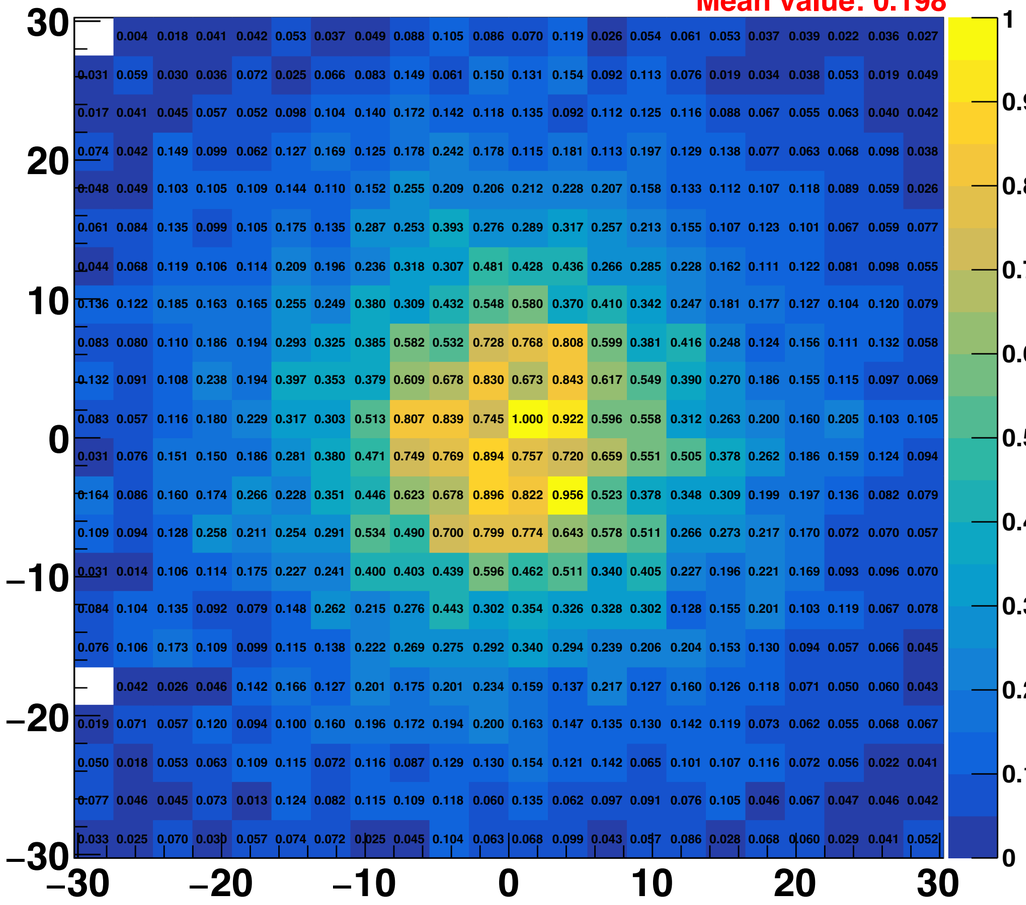
22x22 — Trap — 18 mm

Efficiency - LG - Air - 2cm - 22x22 - 18. mm

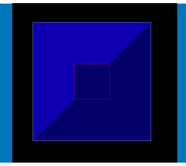


Factor non-uniformity - LG - Air - 2cm - 22x22 - 18. mm

Mean value: 0.198

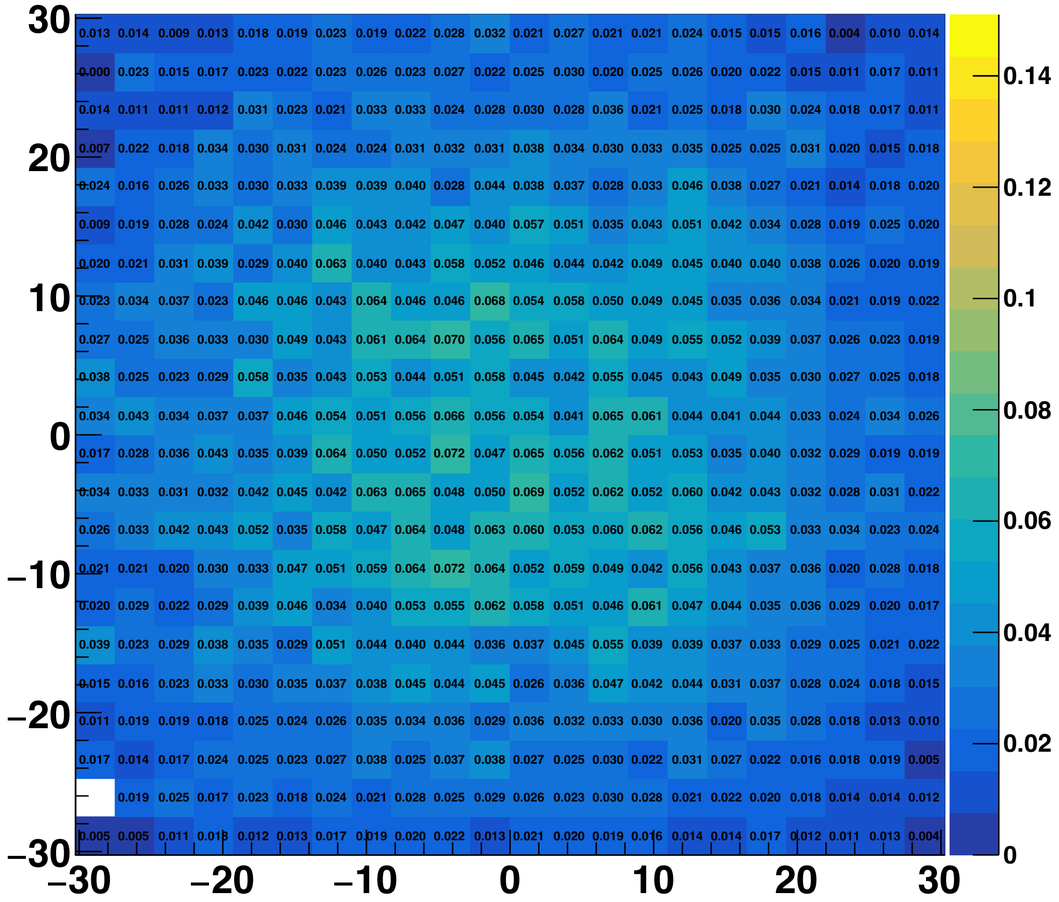


• Geometry 6 AIR



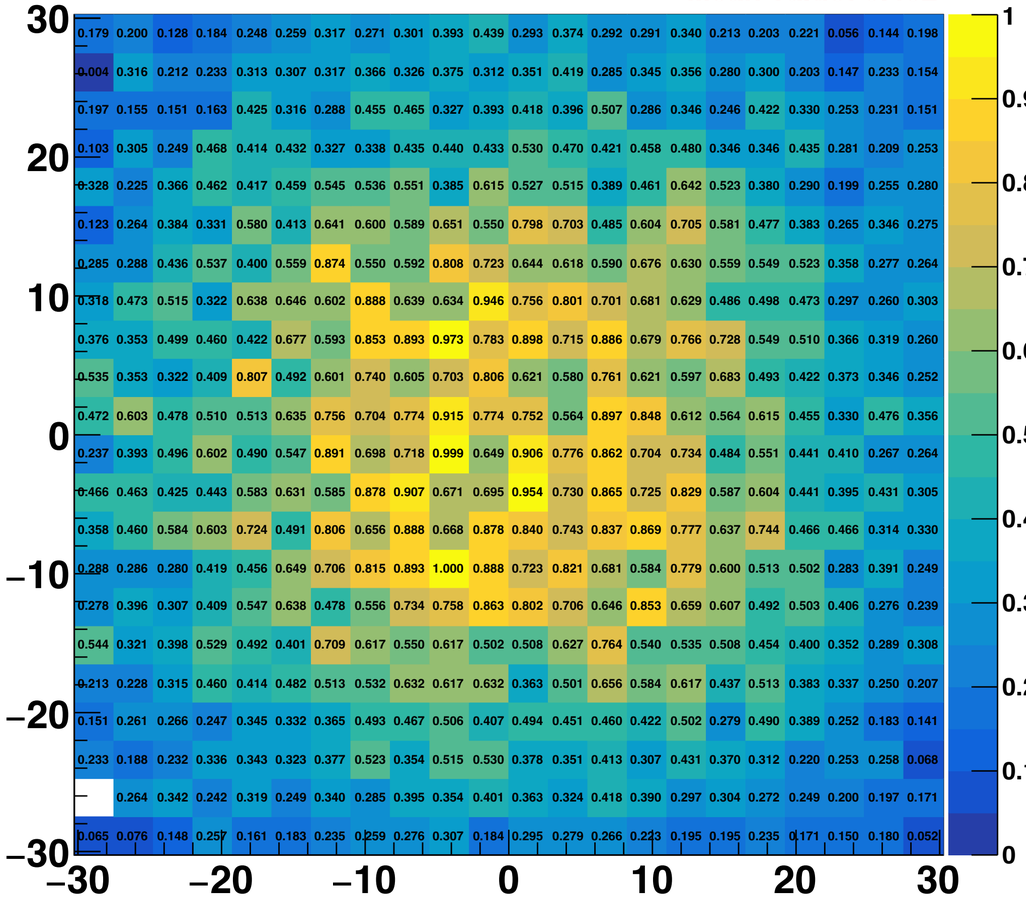
22x22 — Trap — 18 mm

Efficiency - LG - Air - 3cm - 22x22 - 18. mm

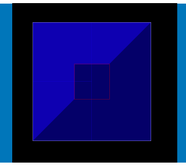


Factor non-uniformity - LG - Air - 3cm - 22x22 - 18. mm

Mean value: 0.462

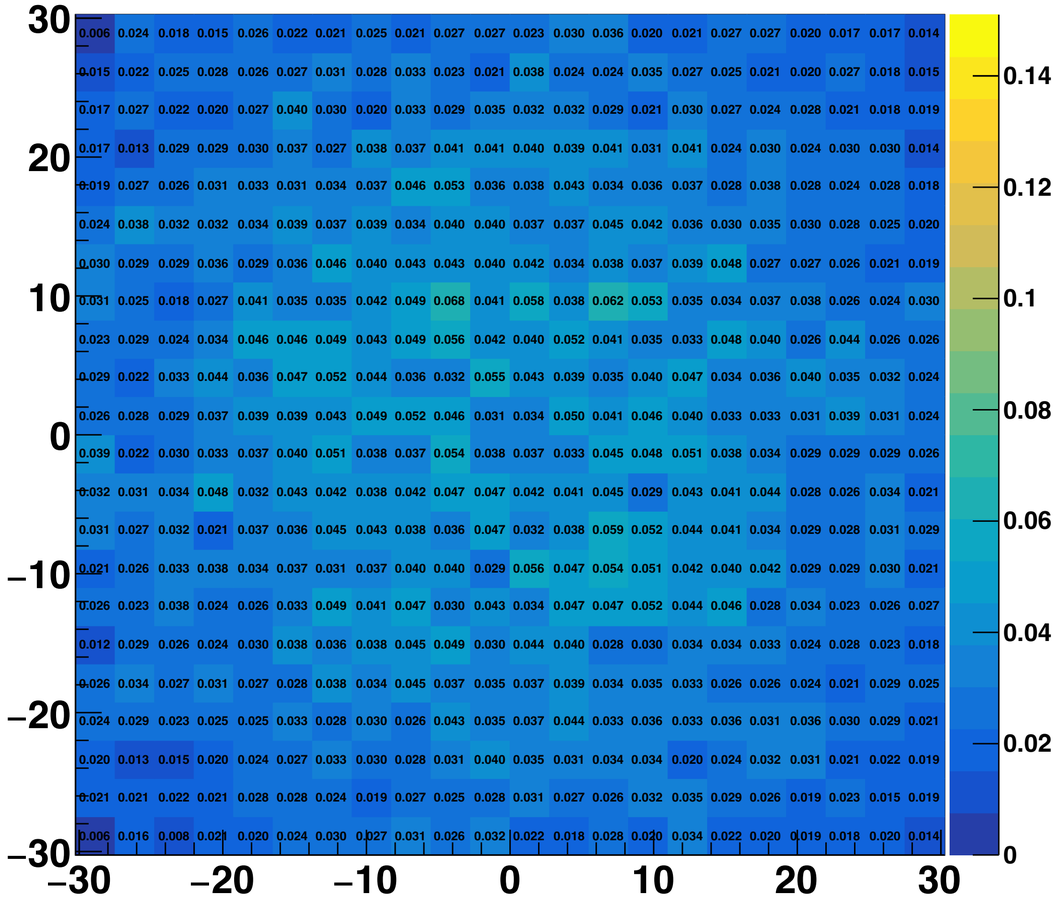


• Geometry 6 AIR



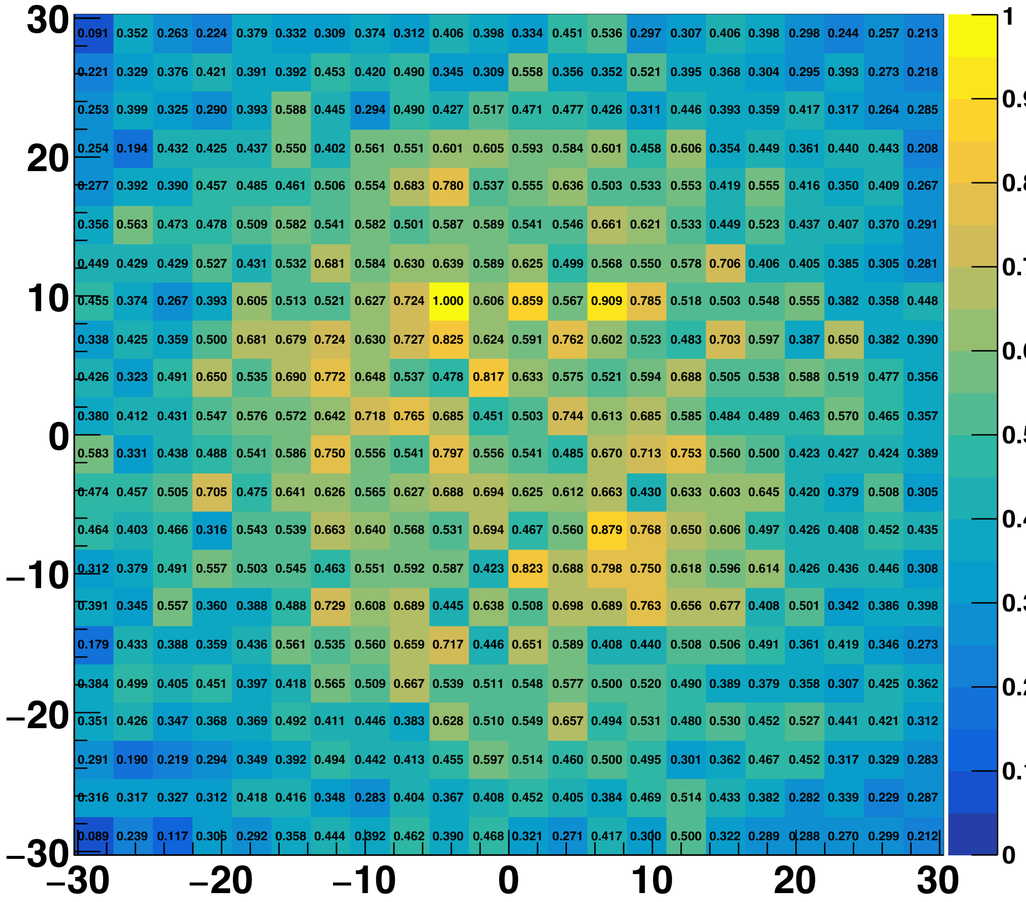
22x22 — Trap — 18 mm

Efficiency - LG - Air - 4cm - 22x22 - 18. mm

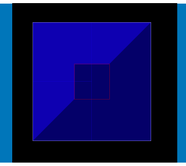


Factor non-uniformity - LG - Air - 4cm - 22x22 - 18. mm

Mean value: 0.477

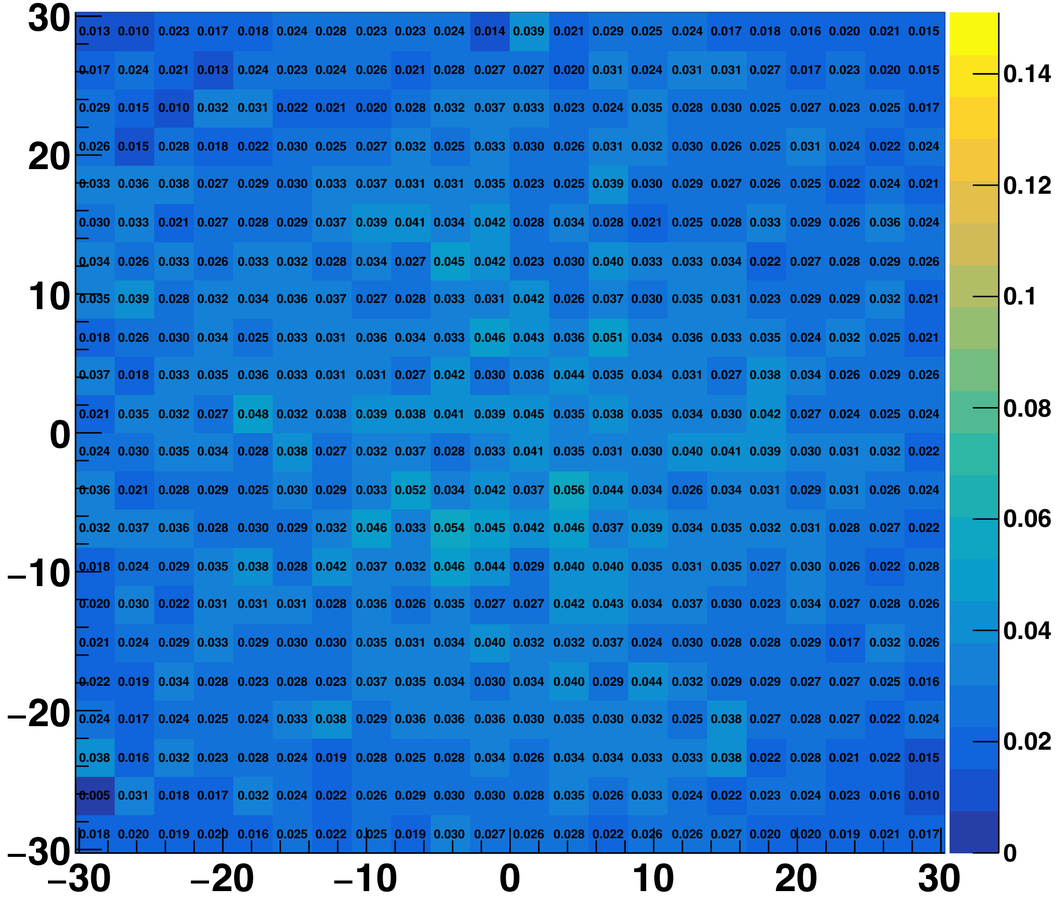


• Geometry 6 AIR



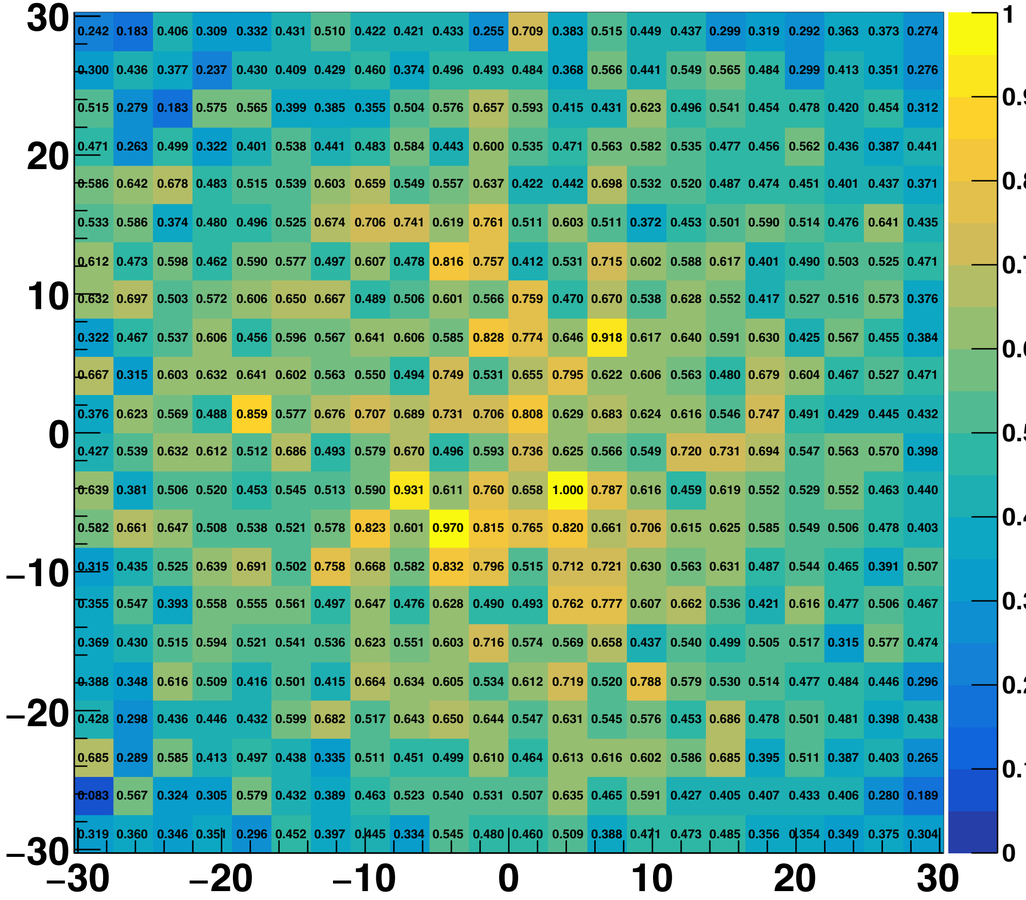
22x22 — Trap — 18 mm

Efficiency - LG - Air - 5cm - 22x22 - 18. mm

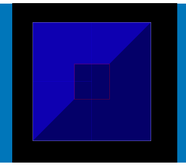


Factor non-uniformity - LG - Air - 5cm - 22x22 - 18. mm

Mean value: 0.527

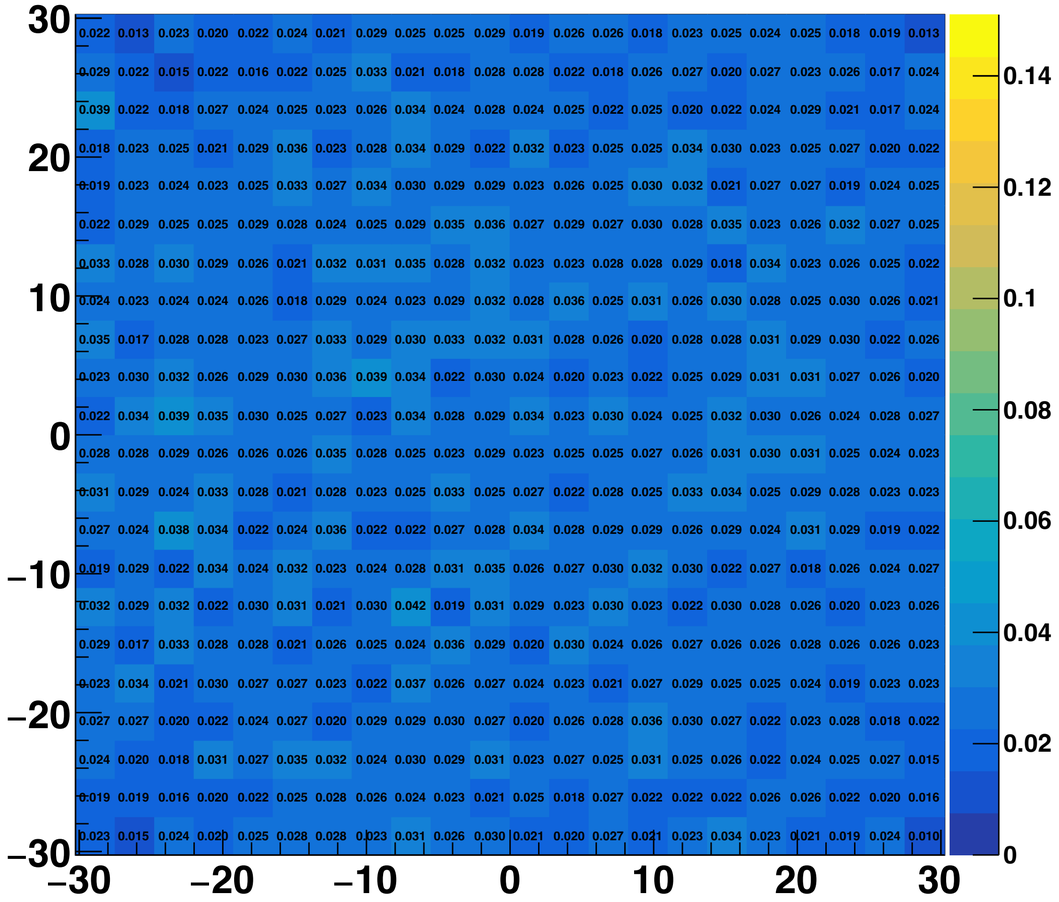


• Geometry 6 AIR



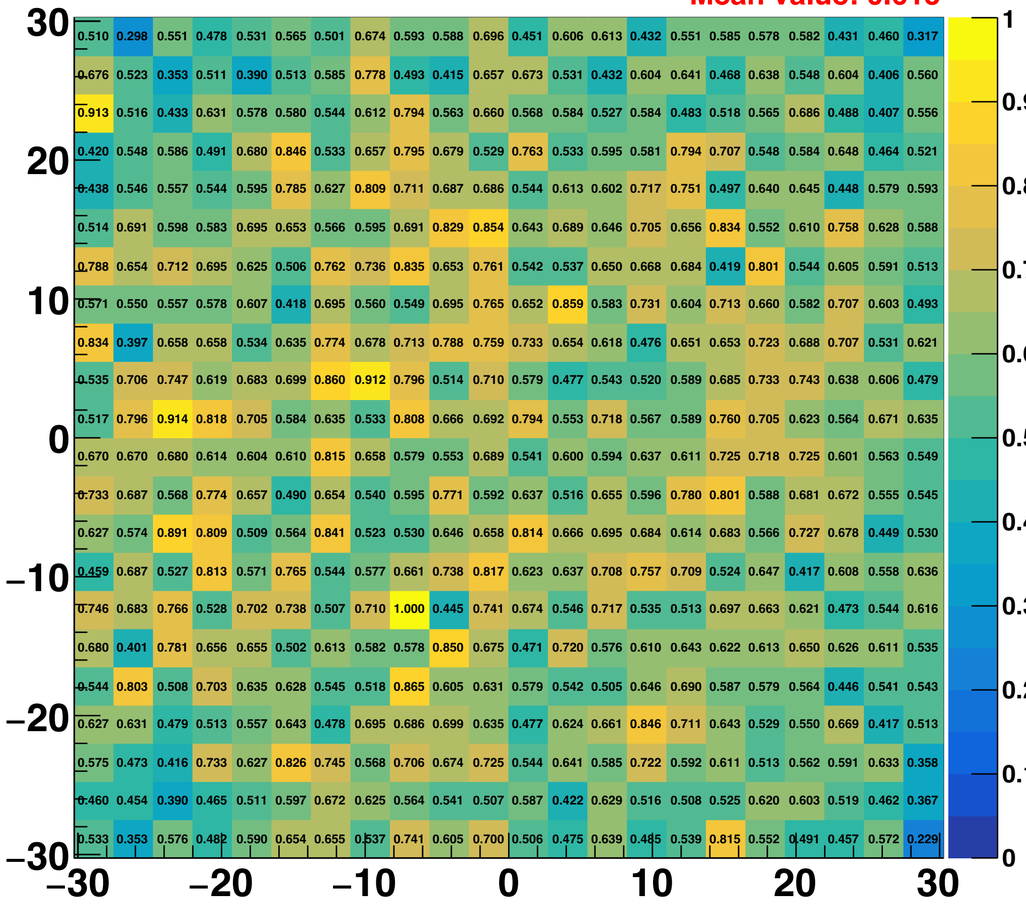
22x22 — Trap — 18 mm

Efficiency - LG - Air - 6cm - 22x22 - 18. mm



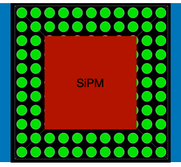
Factor non-uniformity - LG - Air - 6cm - 22x22 - 18. mm

Mean value: 0.615

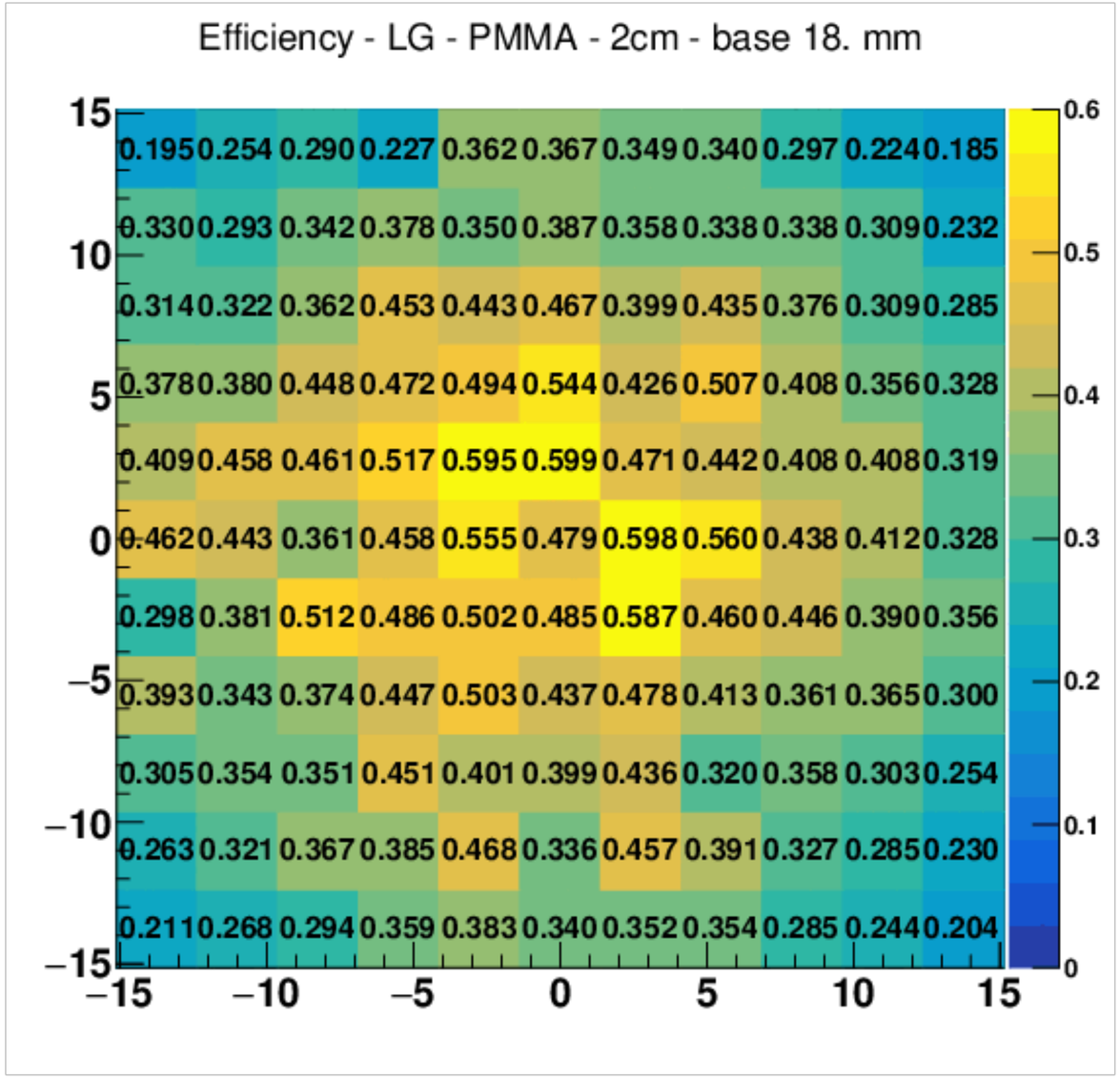


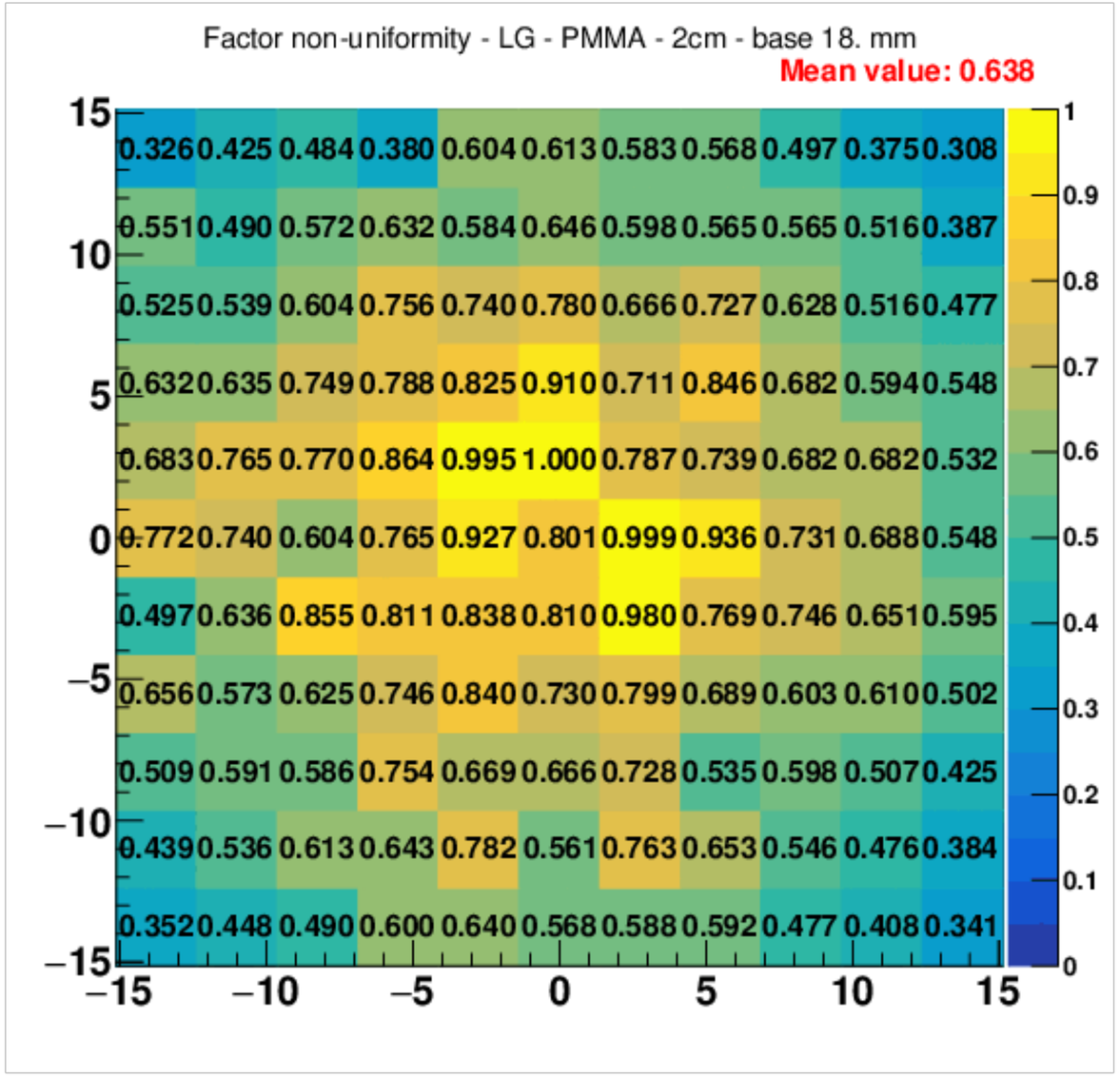
back up slides

geometry 1.1 PMMA

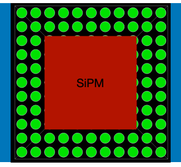


statistic 11.000 - muon 1 GeV

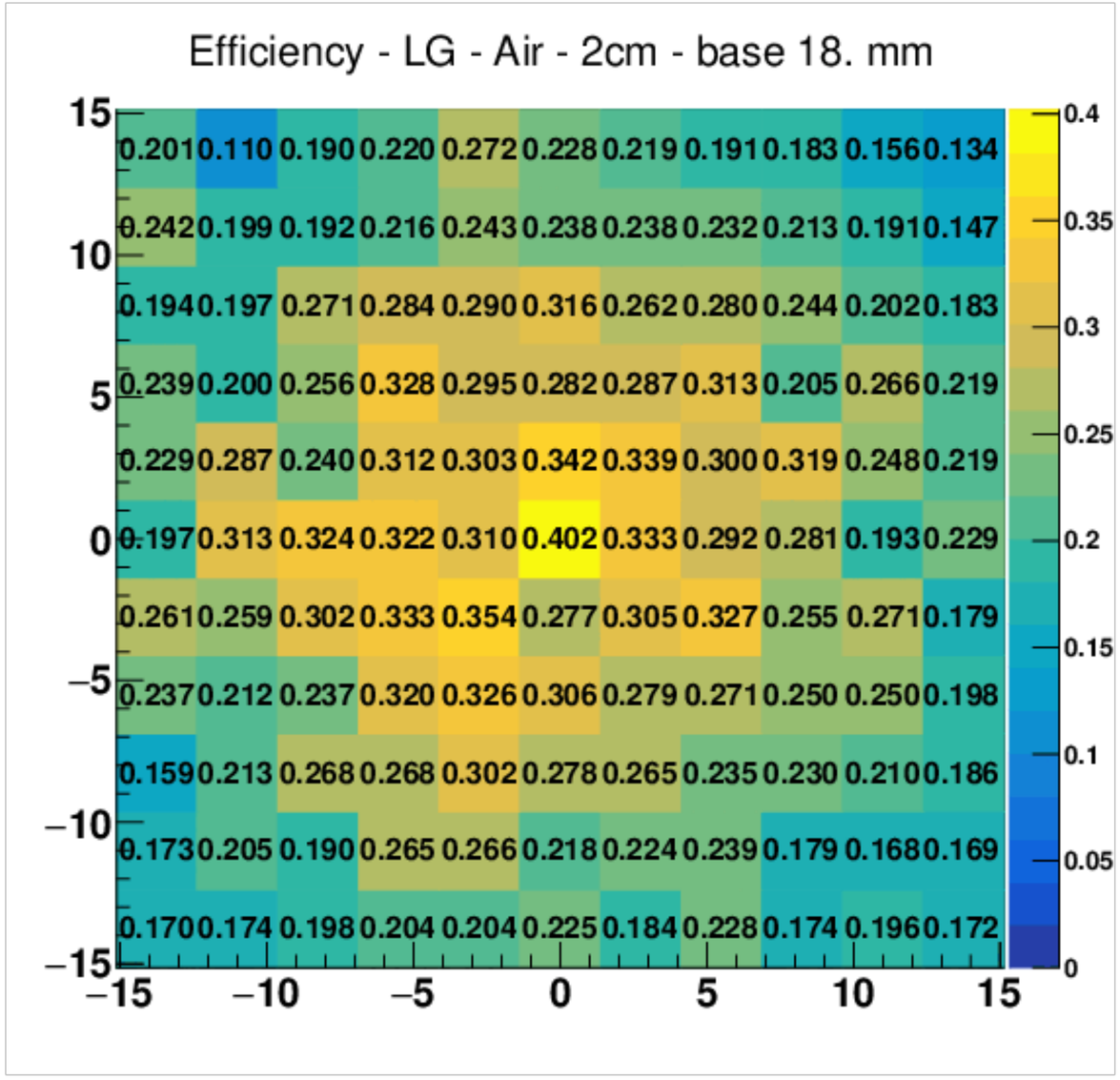


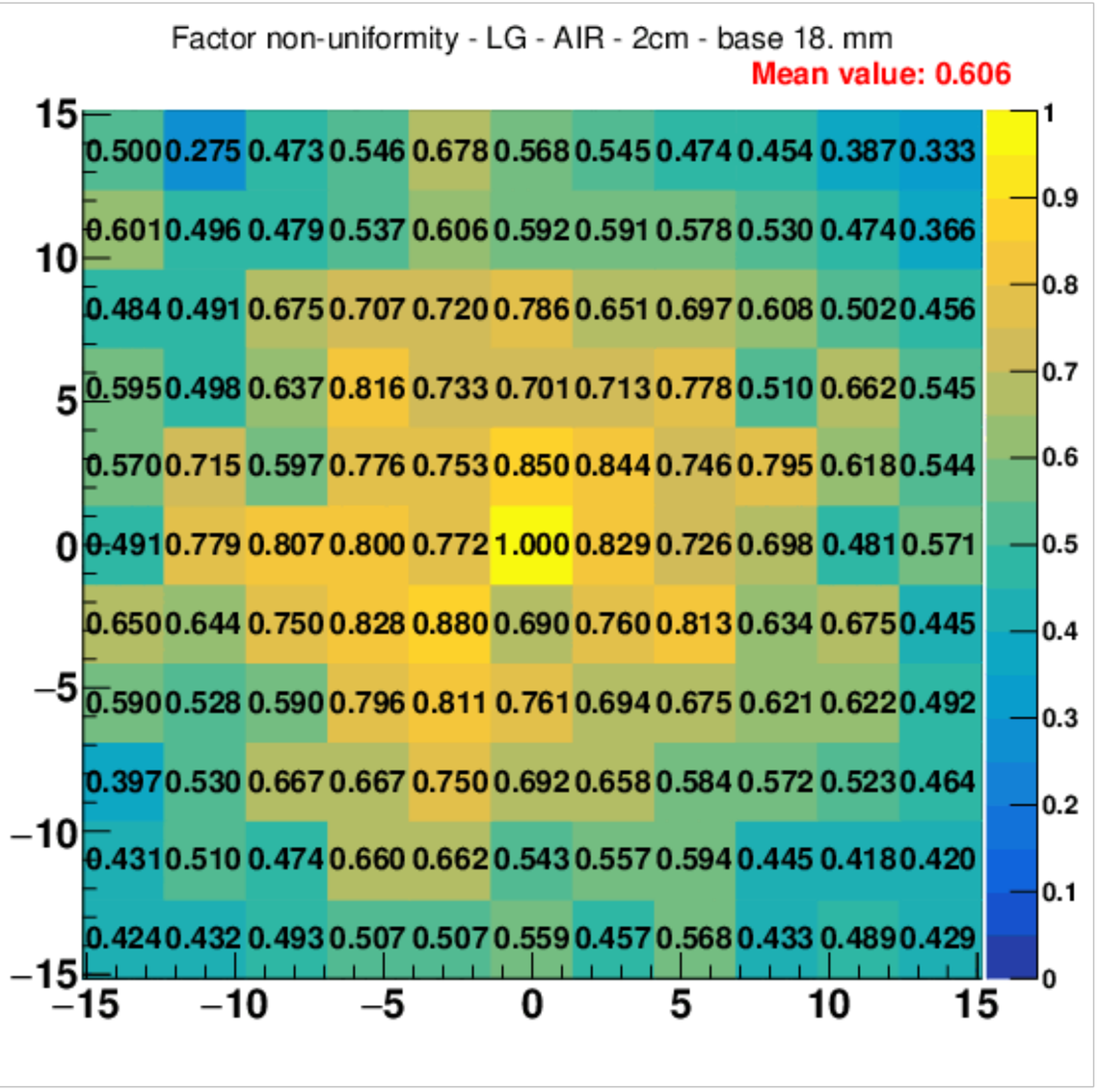


geometry 1.1 AIR

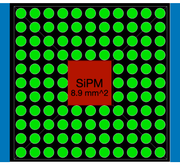


statistic 11.000 - muon 1 GeV

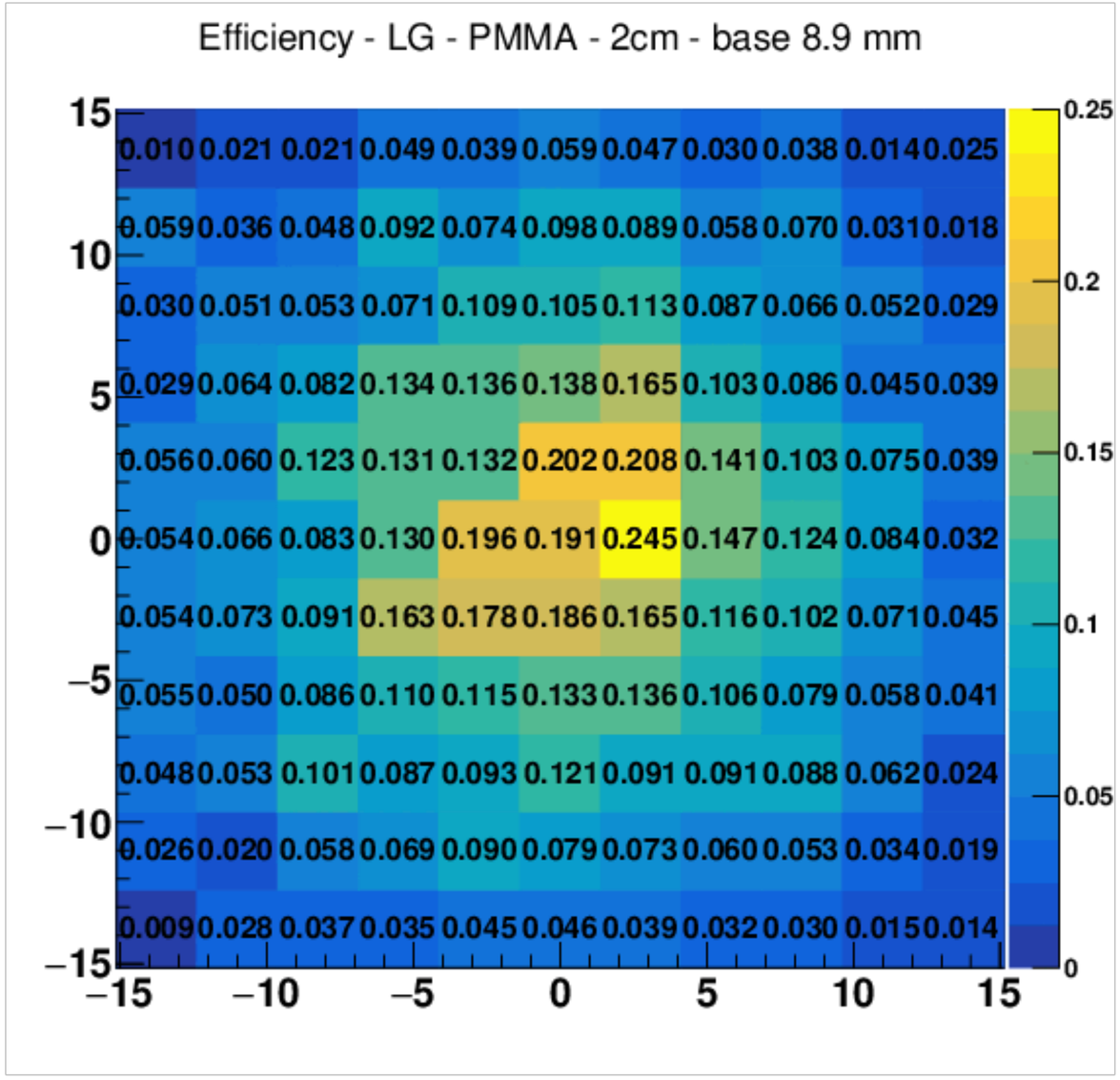


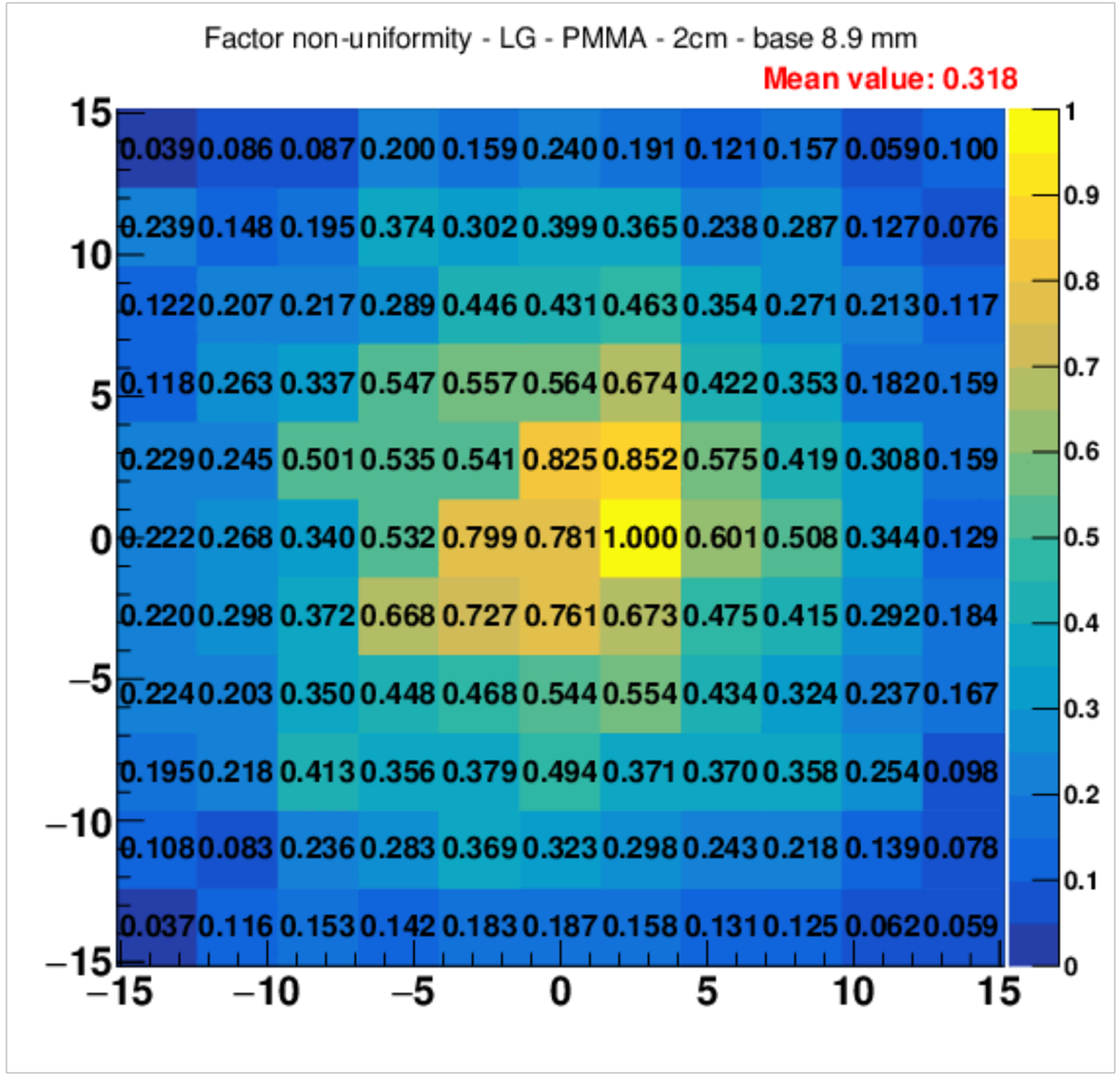


geometry 1.2 PMMA

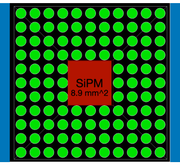


statistic 11.000 - muon 1 GeV

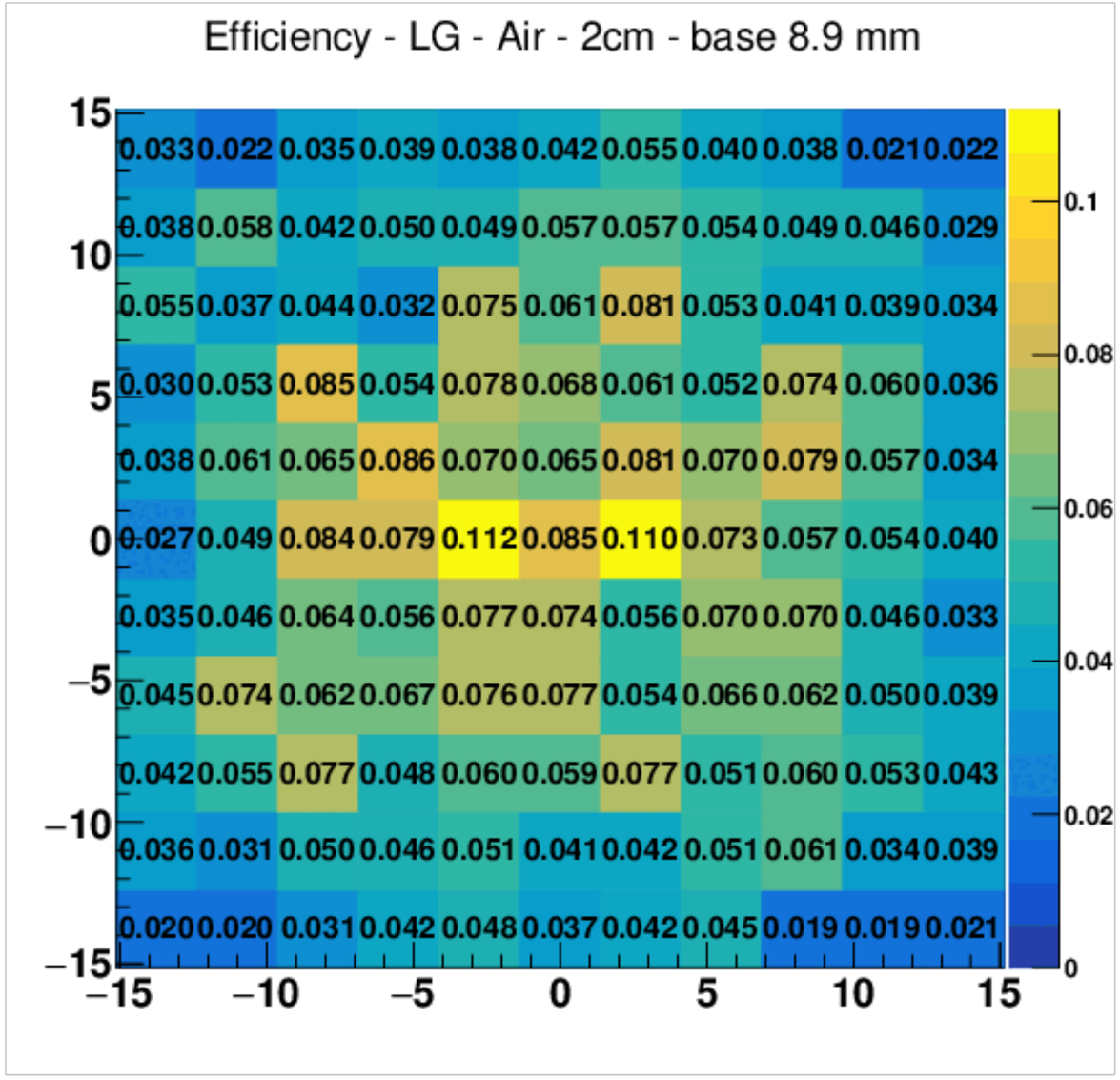


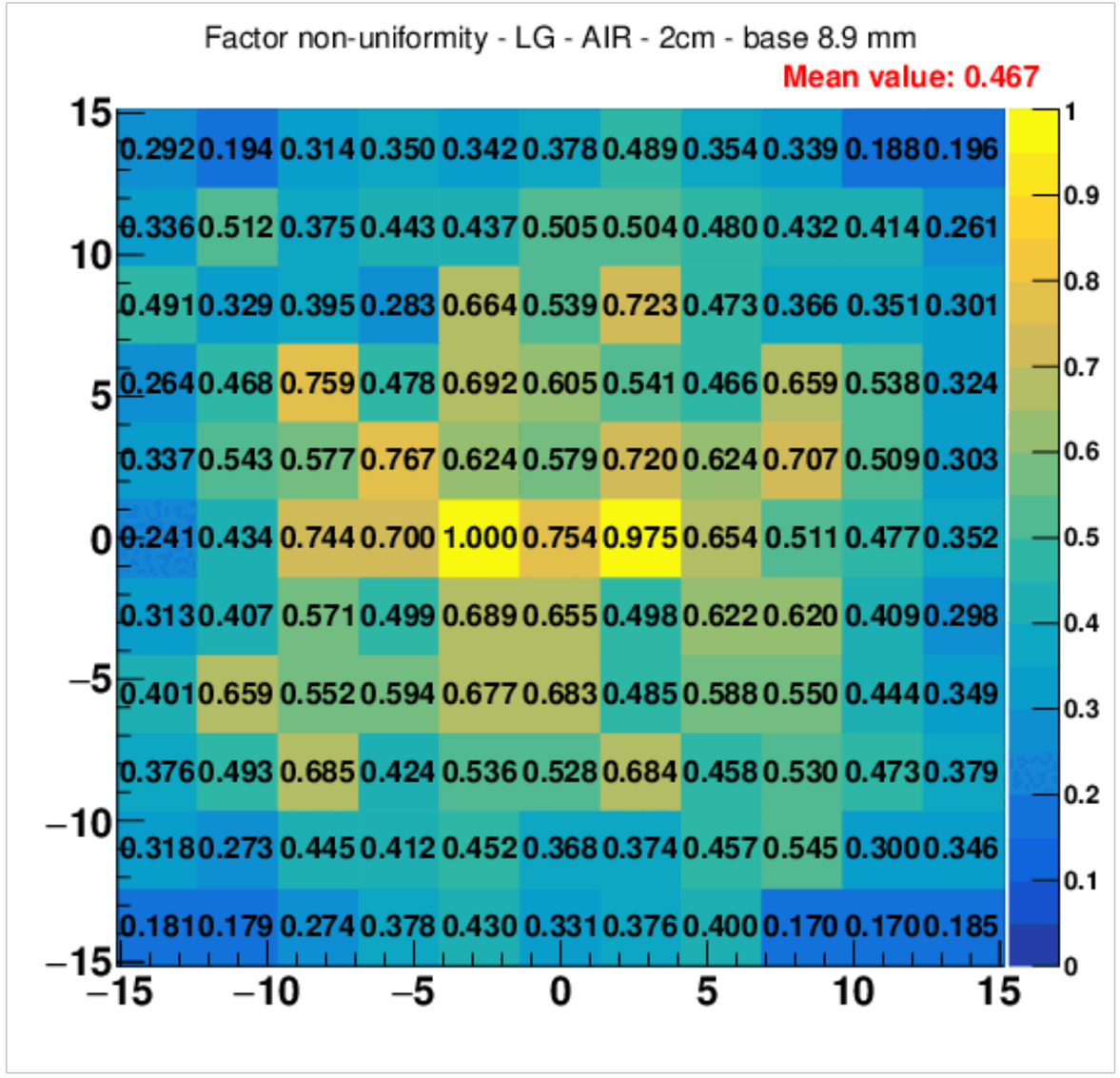


geometry 1.2 AIR

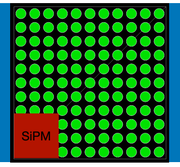


statistic 11.000 - muon 1 GeV

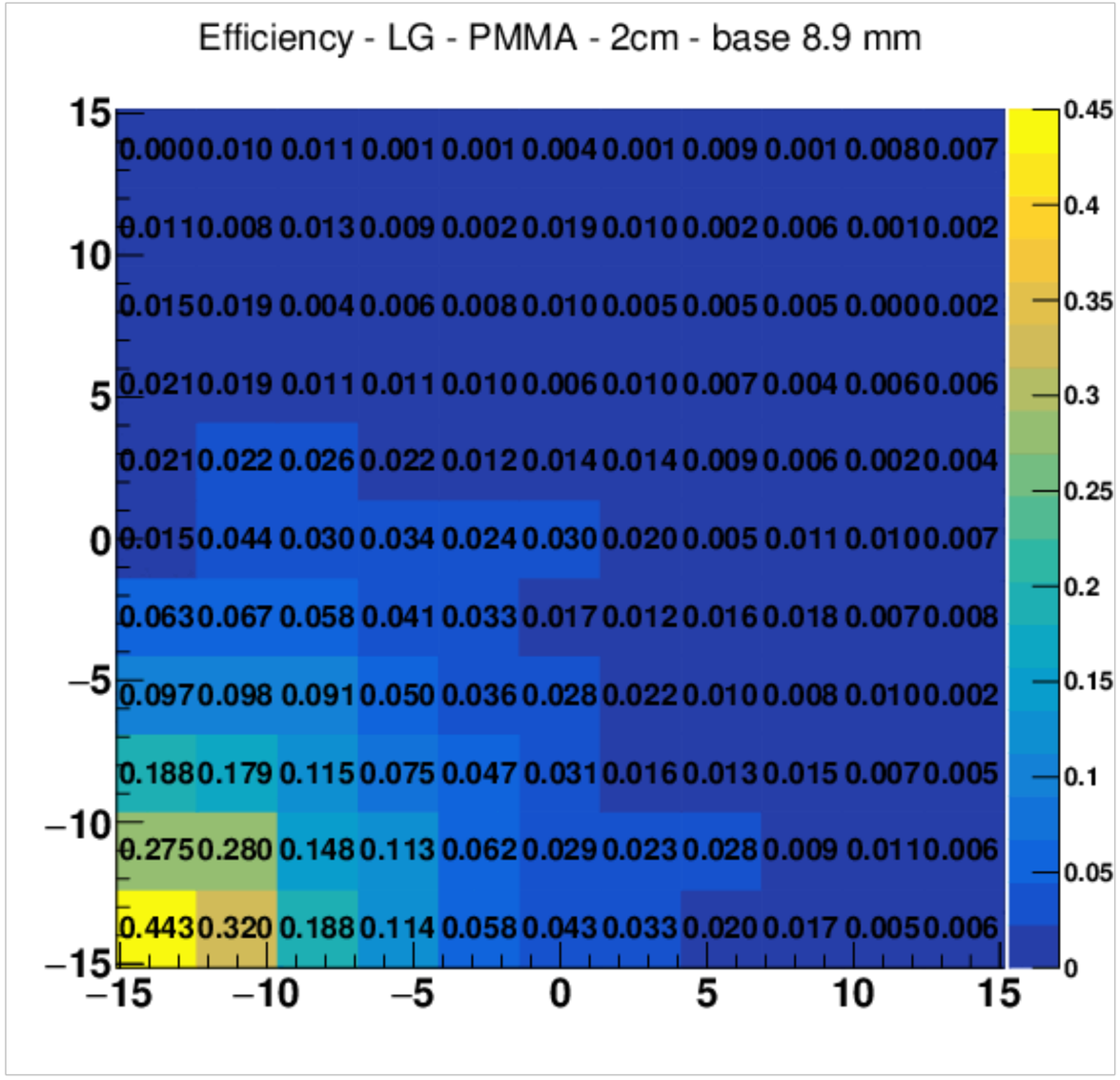


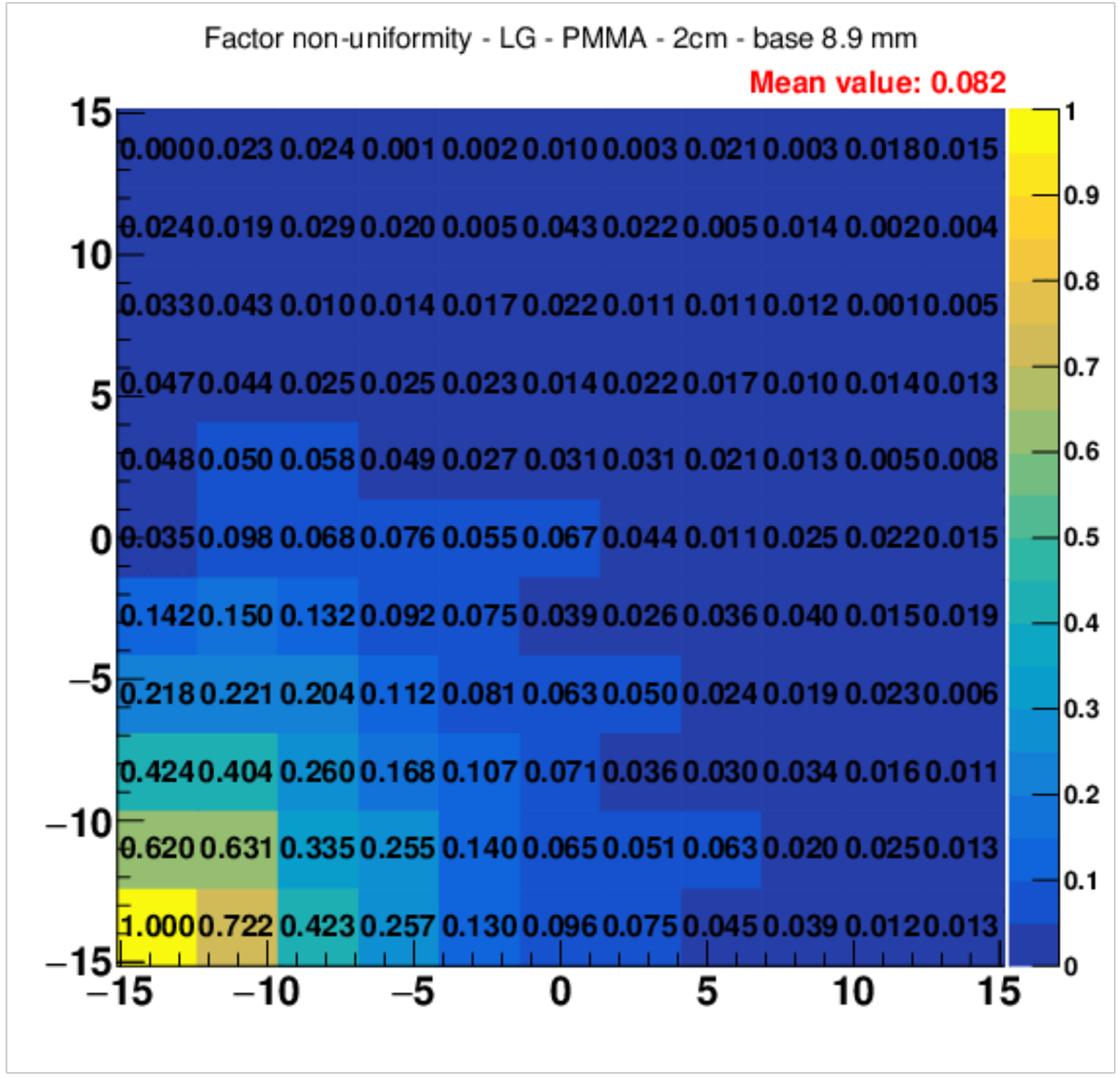


geometry 3 PMMA

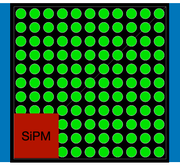


statistic 11.000 - muon 1 GeV

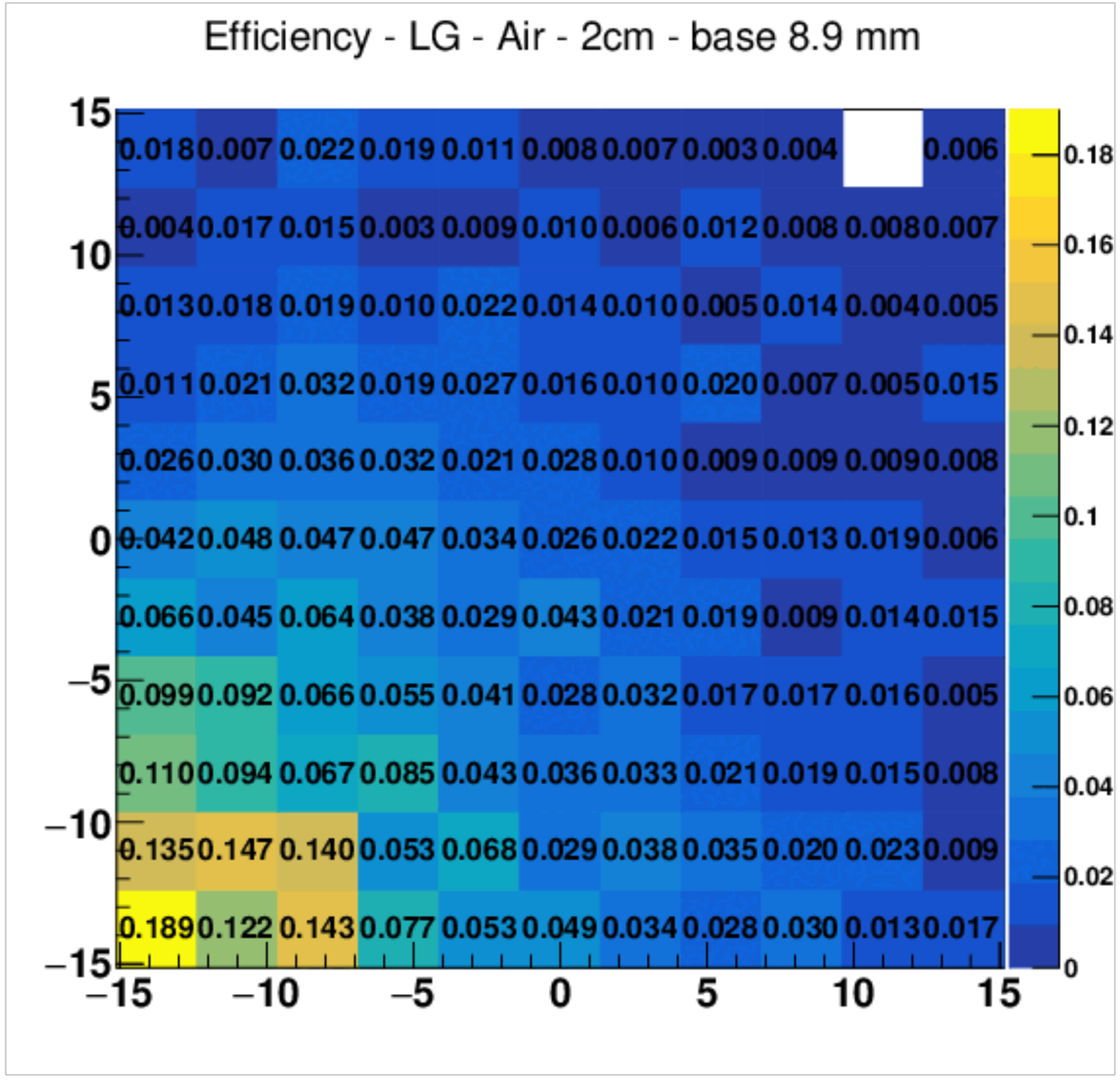


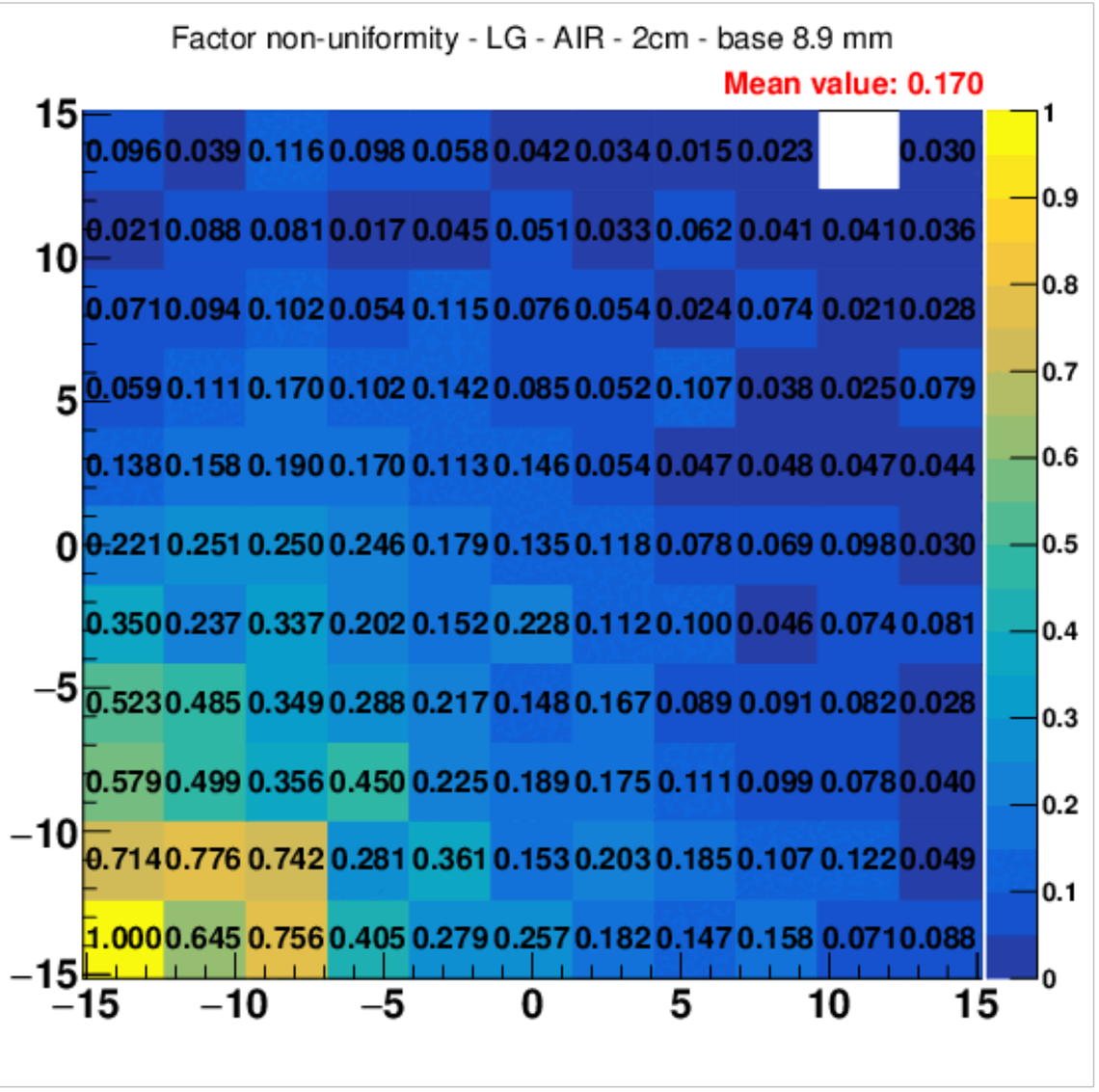


geometry 3 AIR



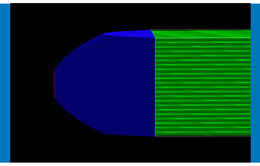
statistic 11.000 - muon 1 GeV





• Geometry 4

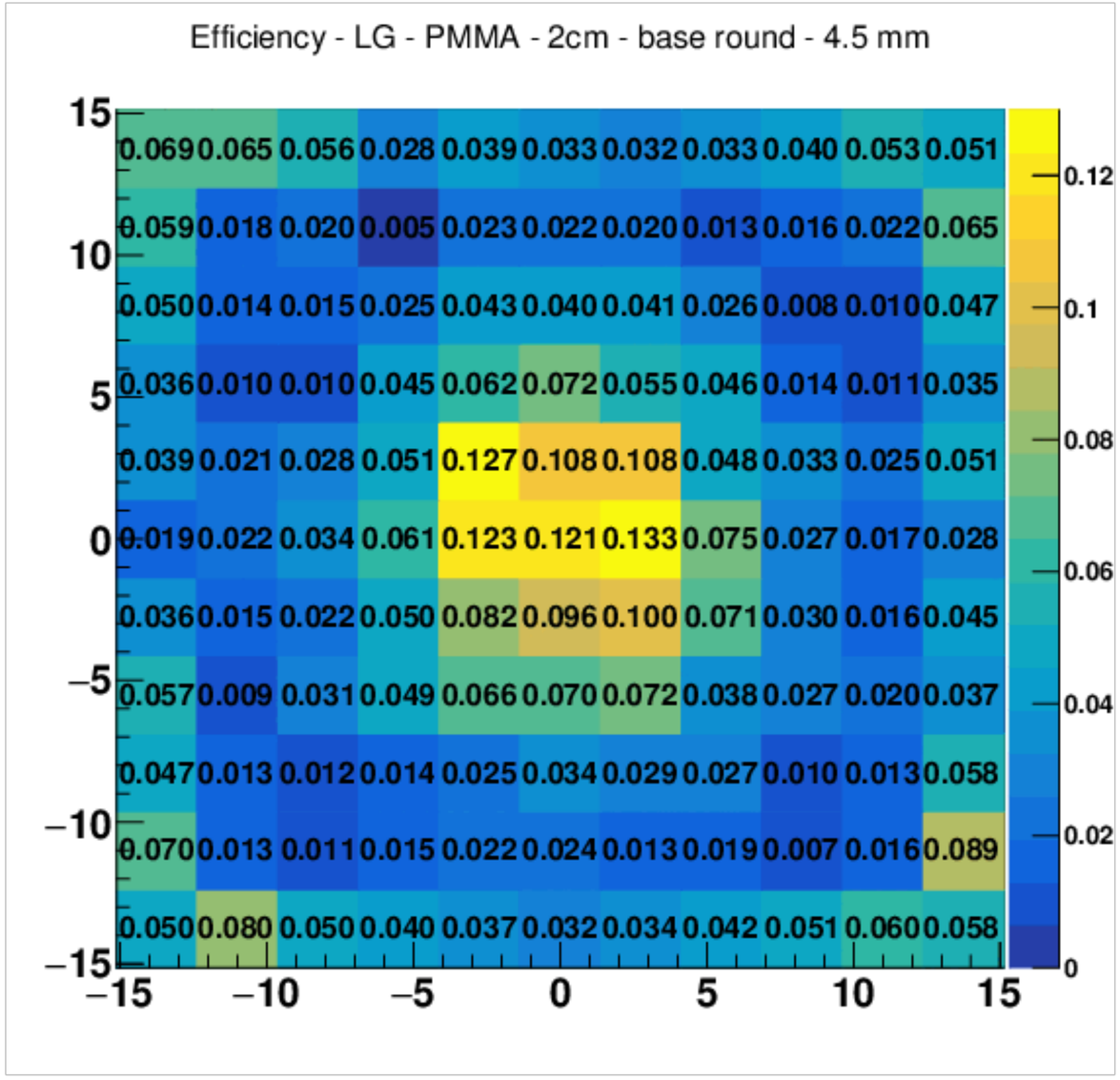
PMMA

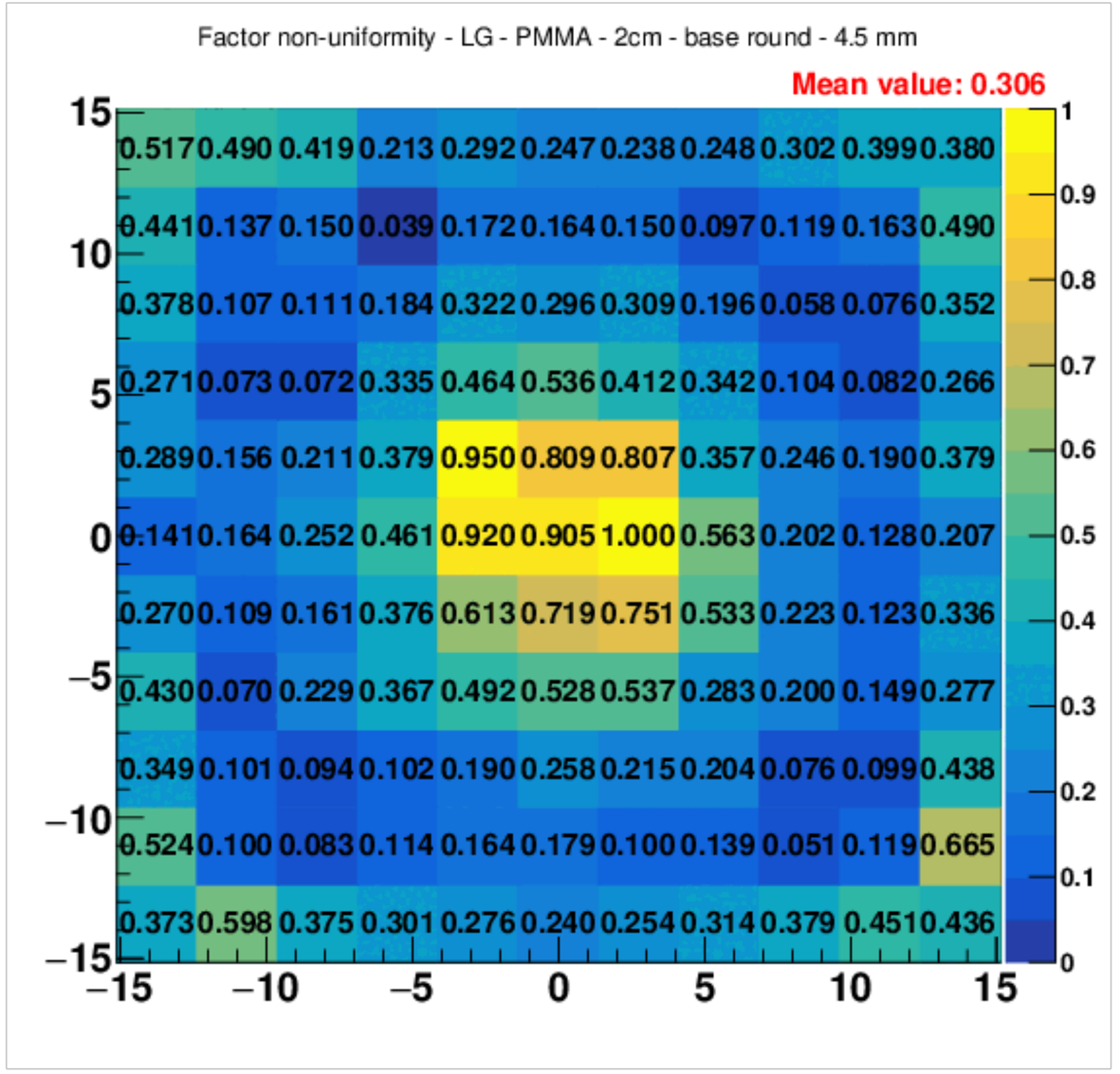


statistic 11.000 - muon 1 GeV

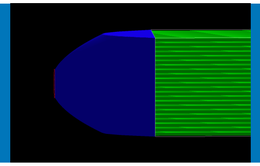
```
G4VSolid* coneS = new G4Paraboloid
("aPara",  0.5*PLEX_depth,PMT_radius,
0.5*sqrt(2)*(lguide_edge-2.0*airGap));
```

Winstone cone
PMT 4.5





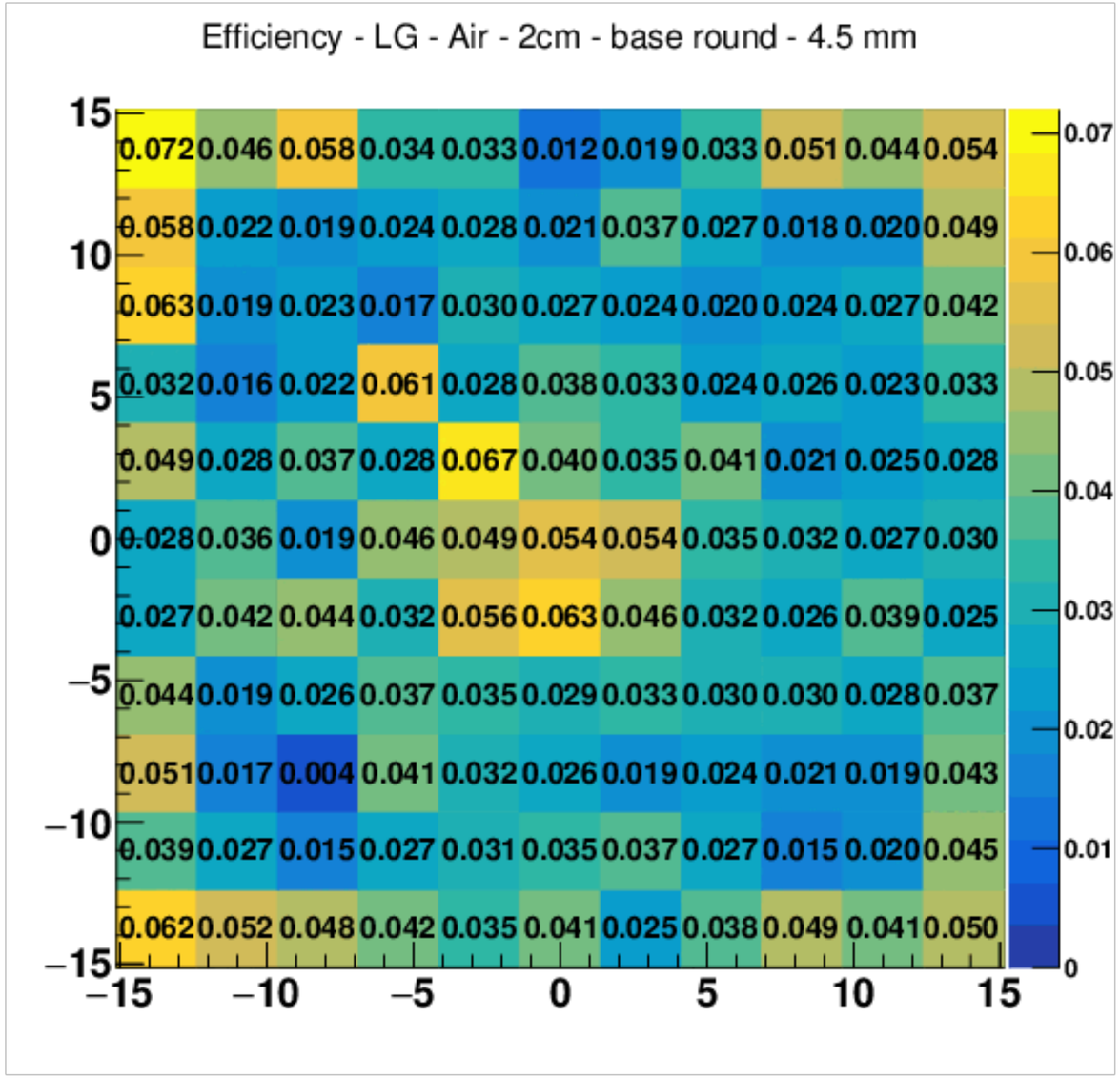
- **Geometry 4** AIR

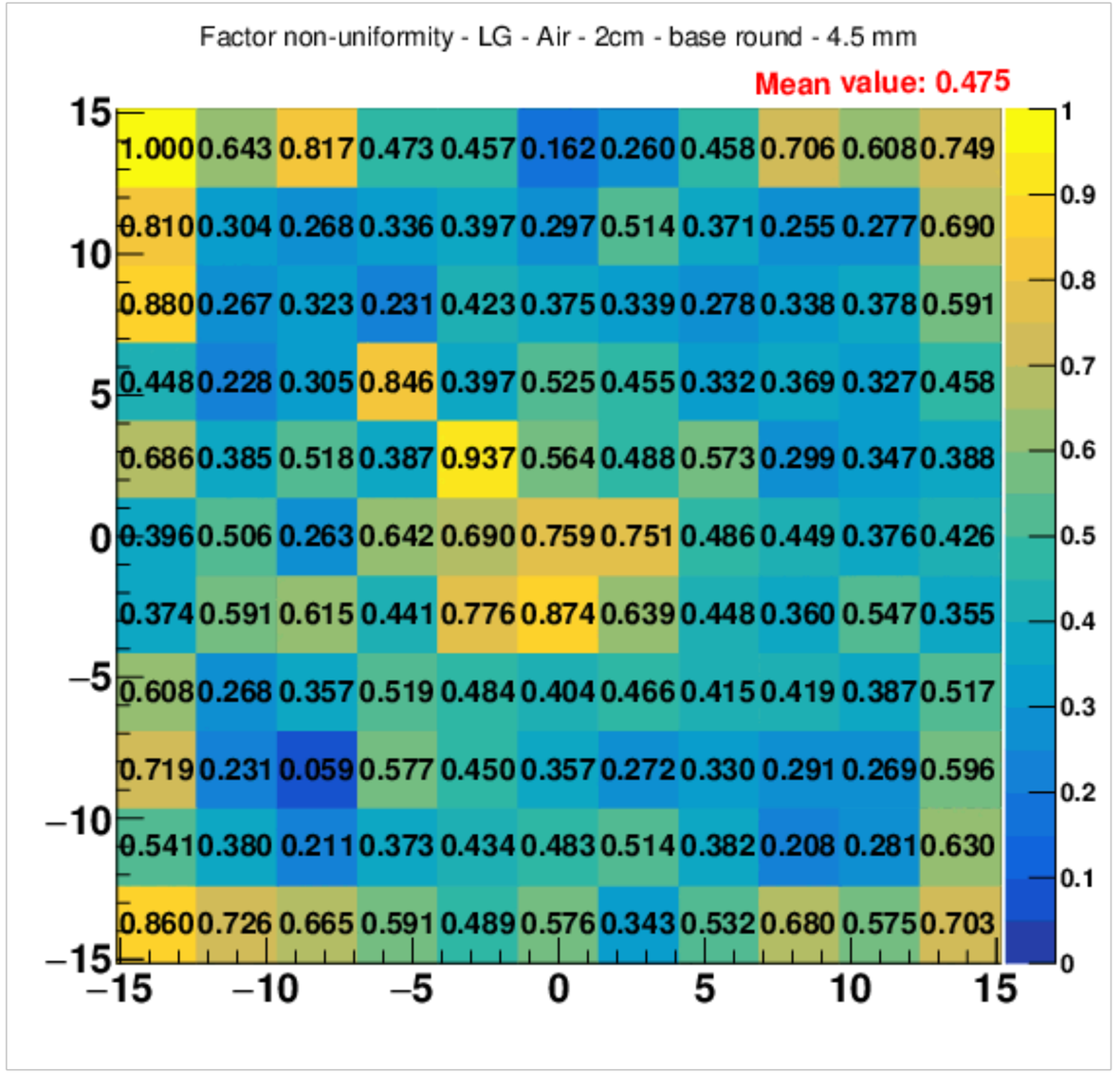


statistic 11.000 - muon 1 GeV

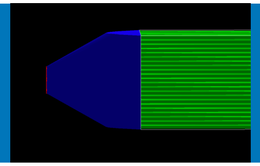
```
G4VSolid* coneS = new G4Paraboloid
("aPara",  0.5*PLEX_depth,PMT_radius,
0.5*sqrt(2)*(lguide_edge-2.0*airGap));
```

Winstone cone
PMT 4.5





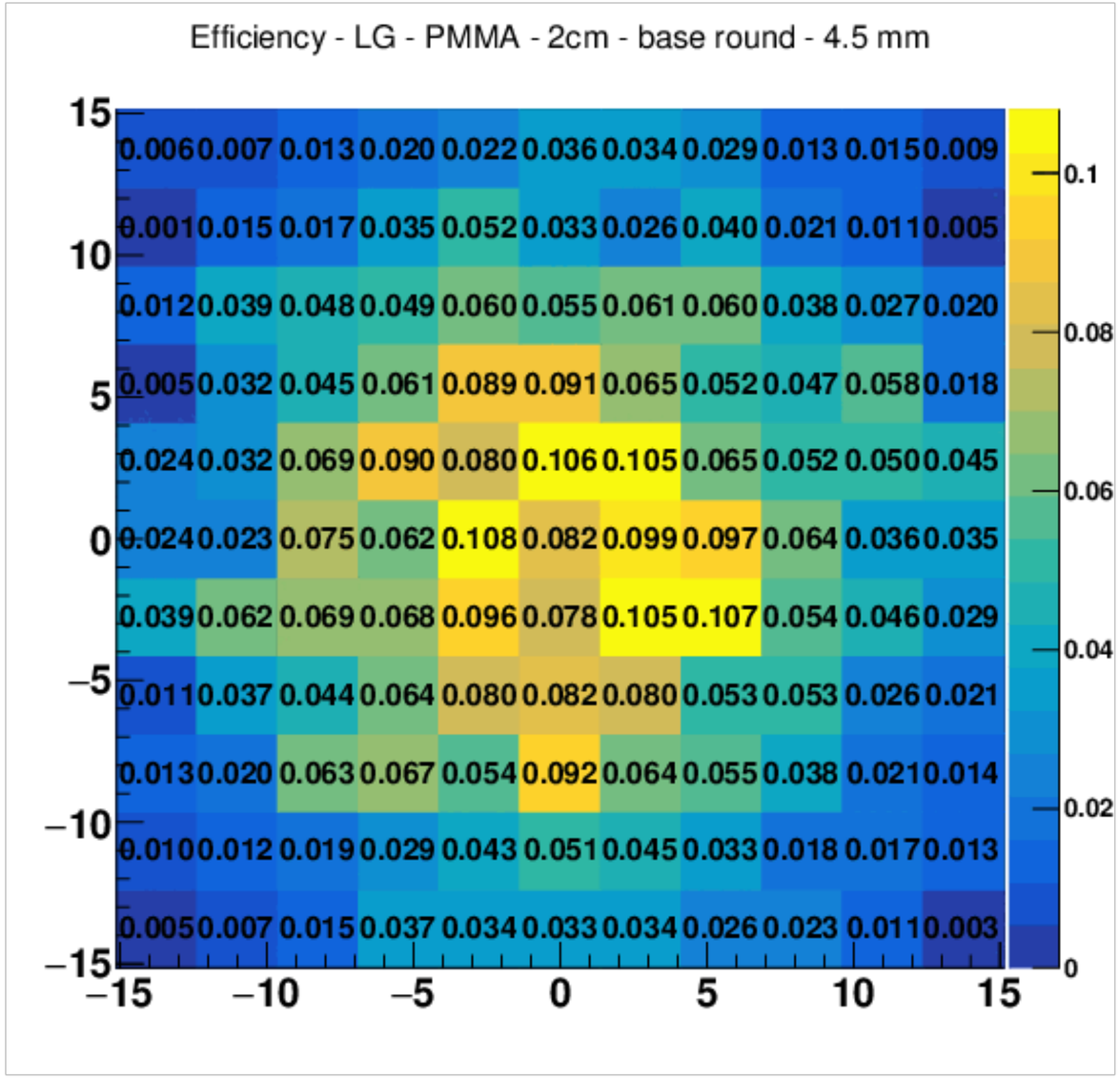
- **Geometry 5** PMMA

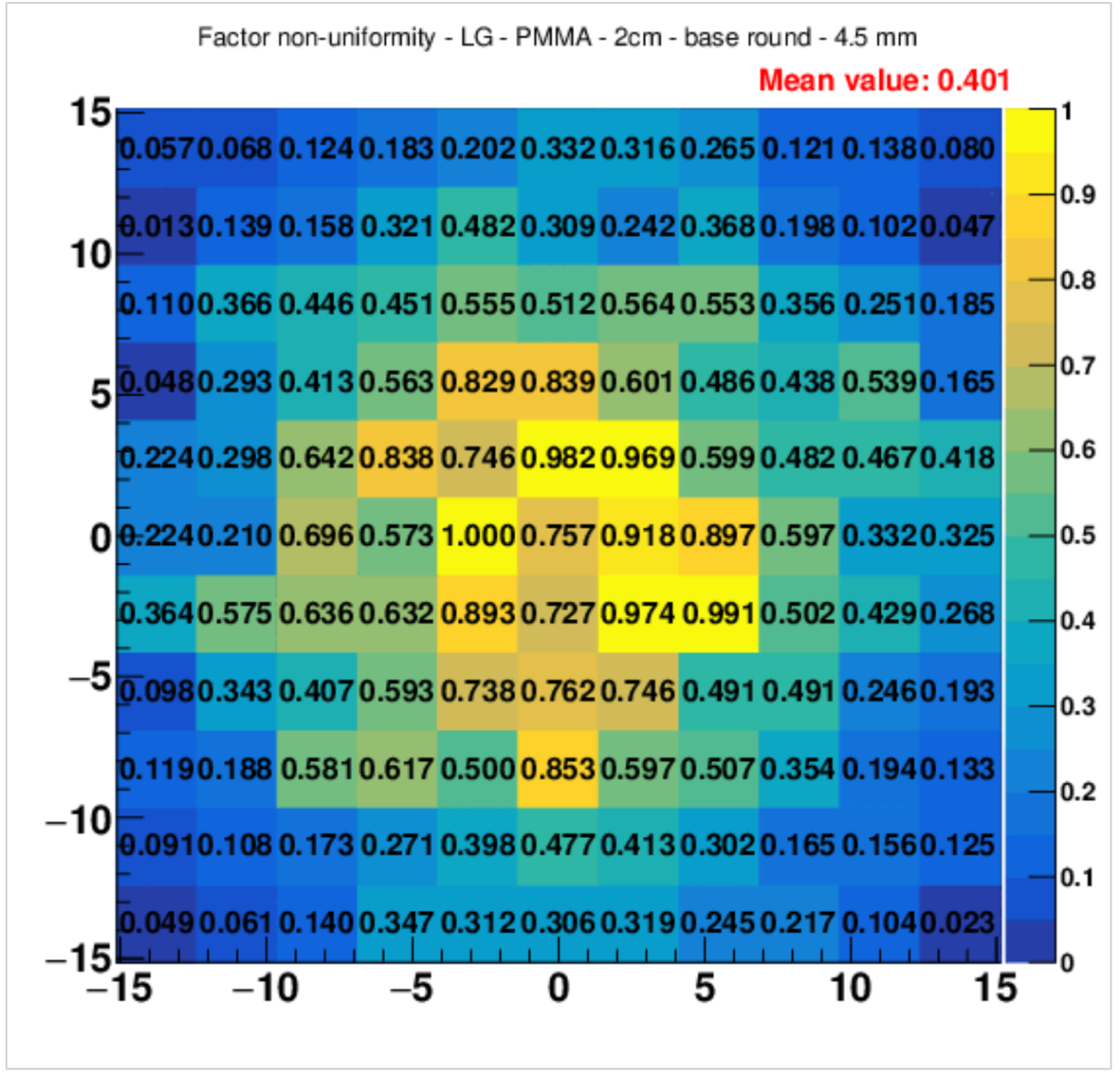


statistic 11.000 - muon 1 GeV

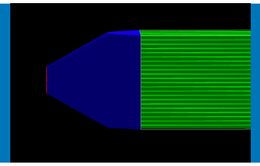
```
G4VSolid* coneS = new G4Paraboloid
("aPara",  0.5*PLEX_depth,PMT_radius,
0.5*sqrt(2)*(lguide_edge-2.0*airGap));
```

FISH TAIL
PMT 4.5





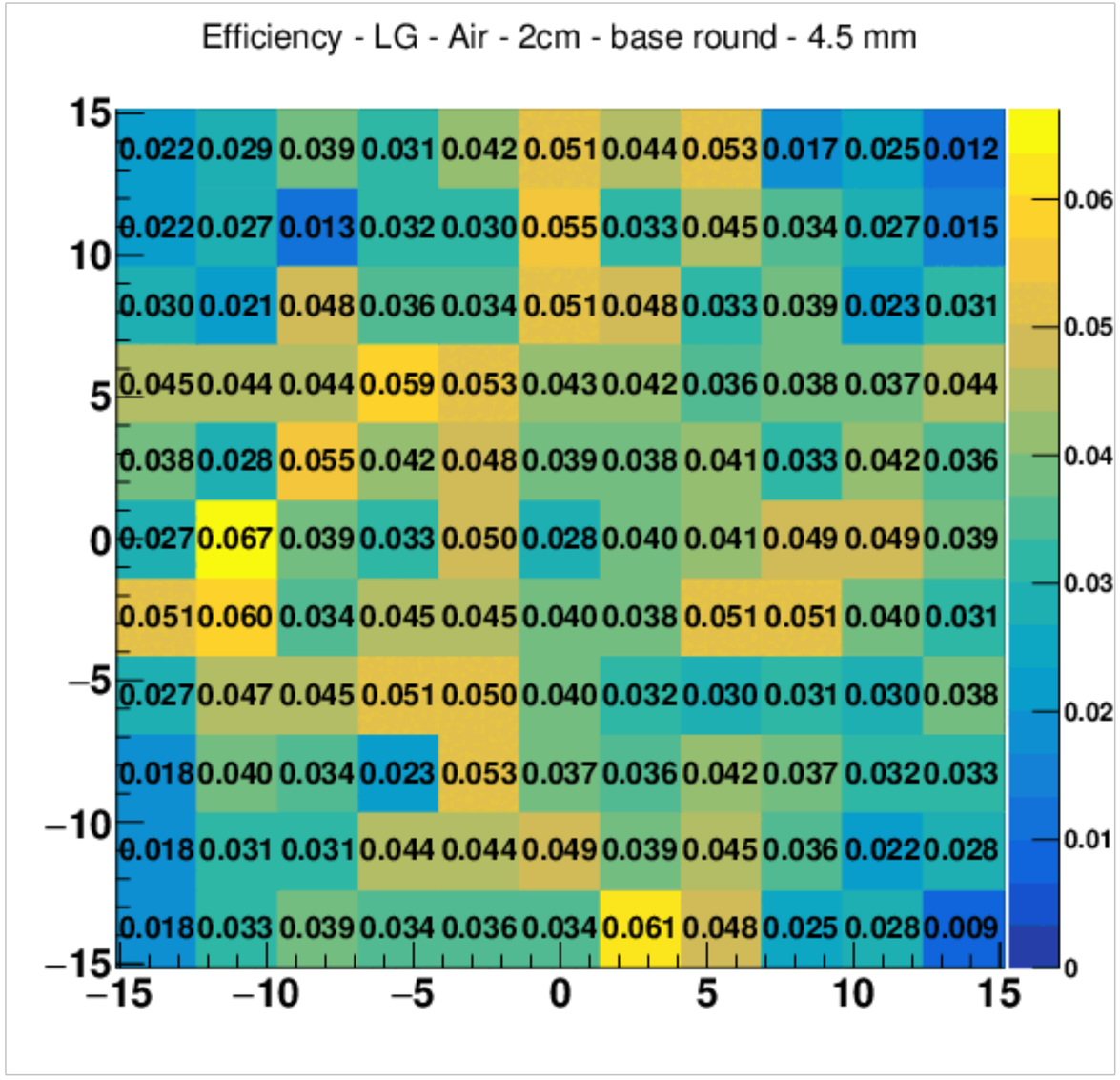
- **Geometry 5** AIR

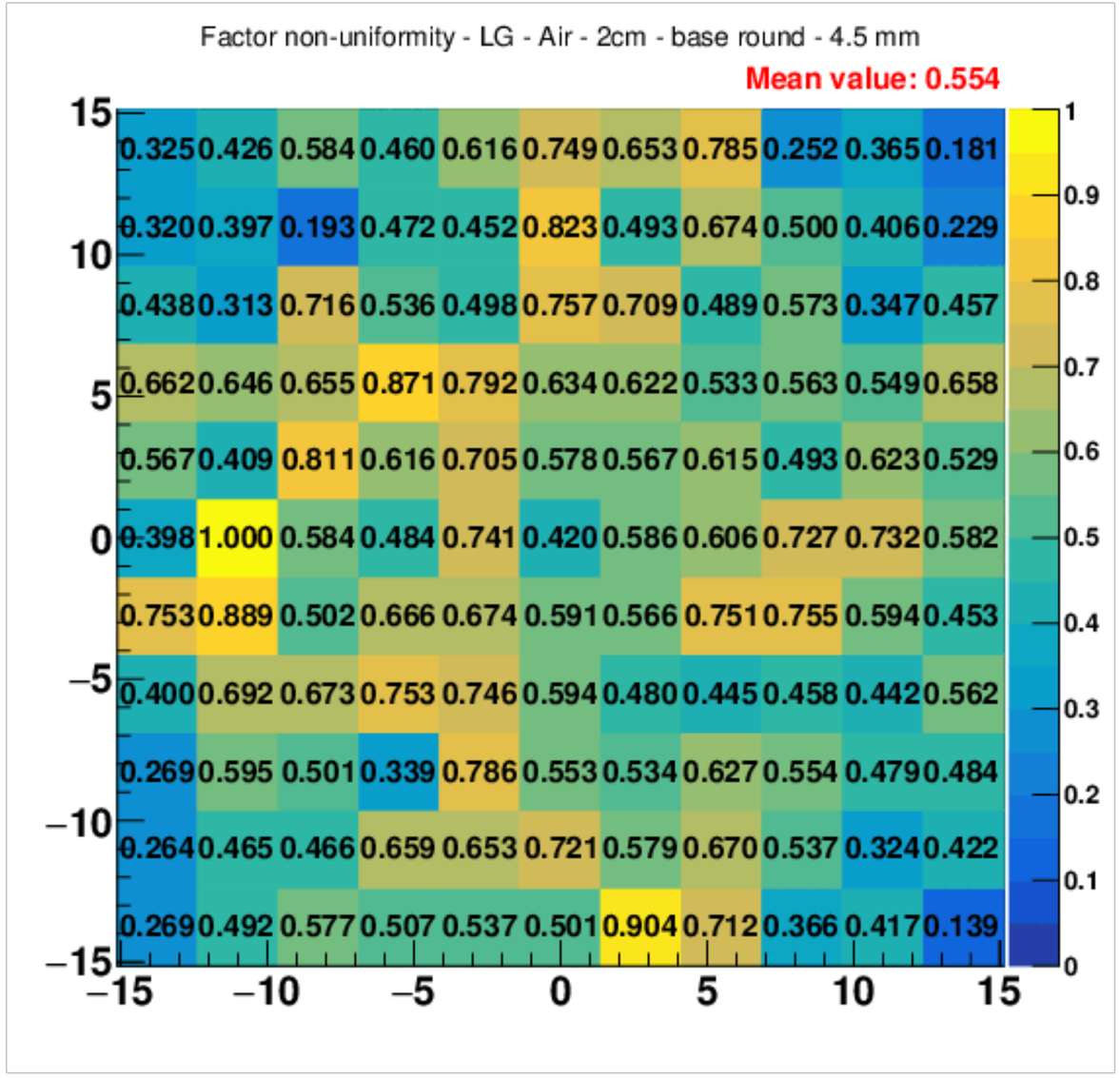


statistic 11.000 - muon 1 GeV

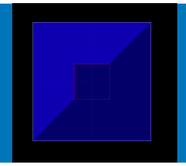
```
G4VSolid* coneS = new G4Paraboloid
("aPara",  0.5*PLEX_depth,PMT_radius,
0.5*sqrt(2)*(lguide_edge-2.0*airGap));
```

FISH TAIL
PMT 4.5

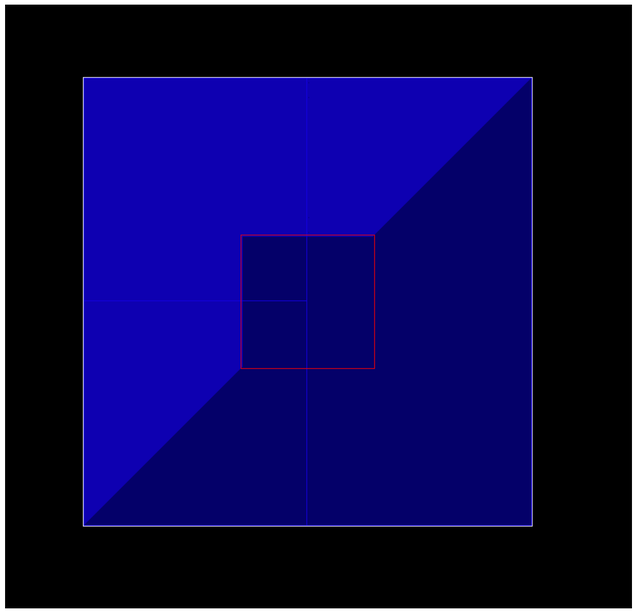


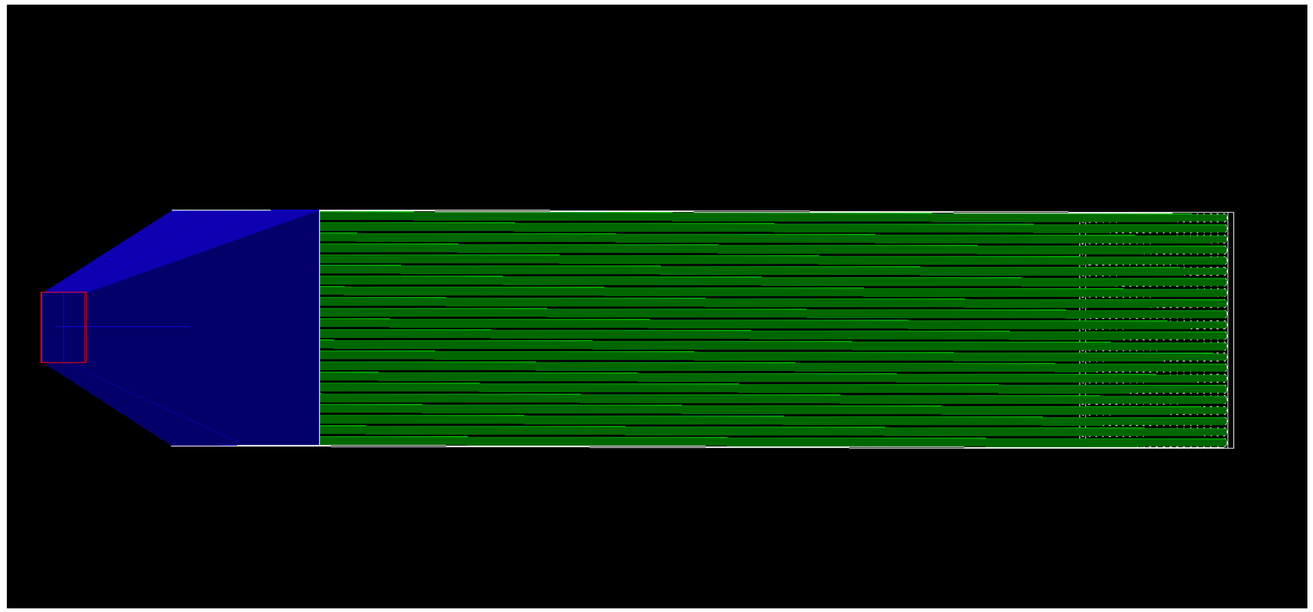


- **Geometry 6**

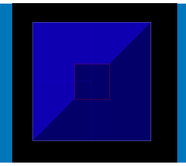


22x22 — Trap — 18 mm

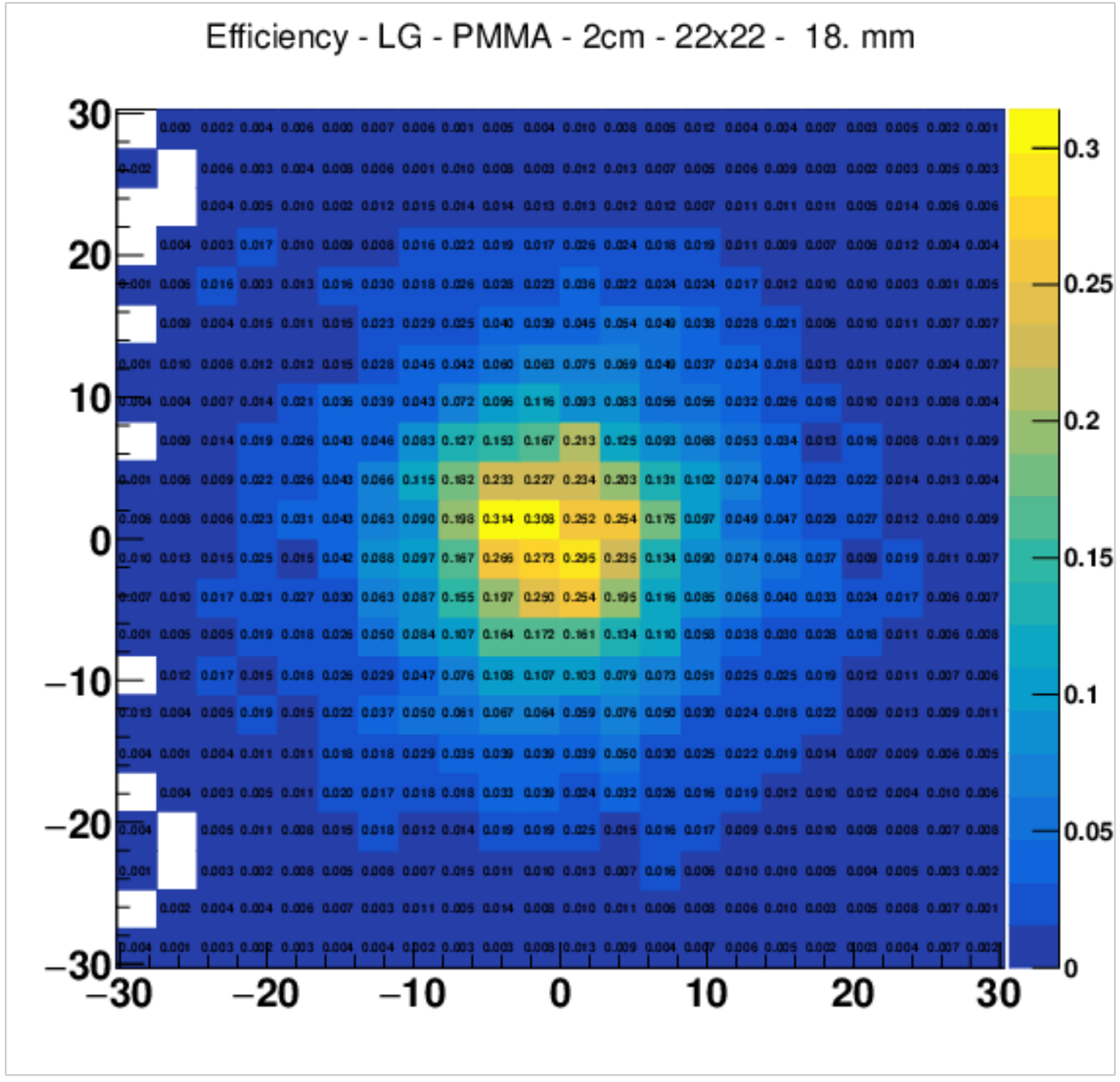


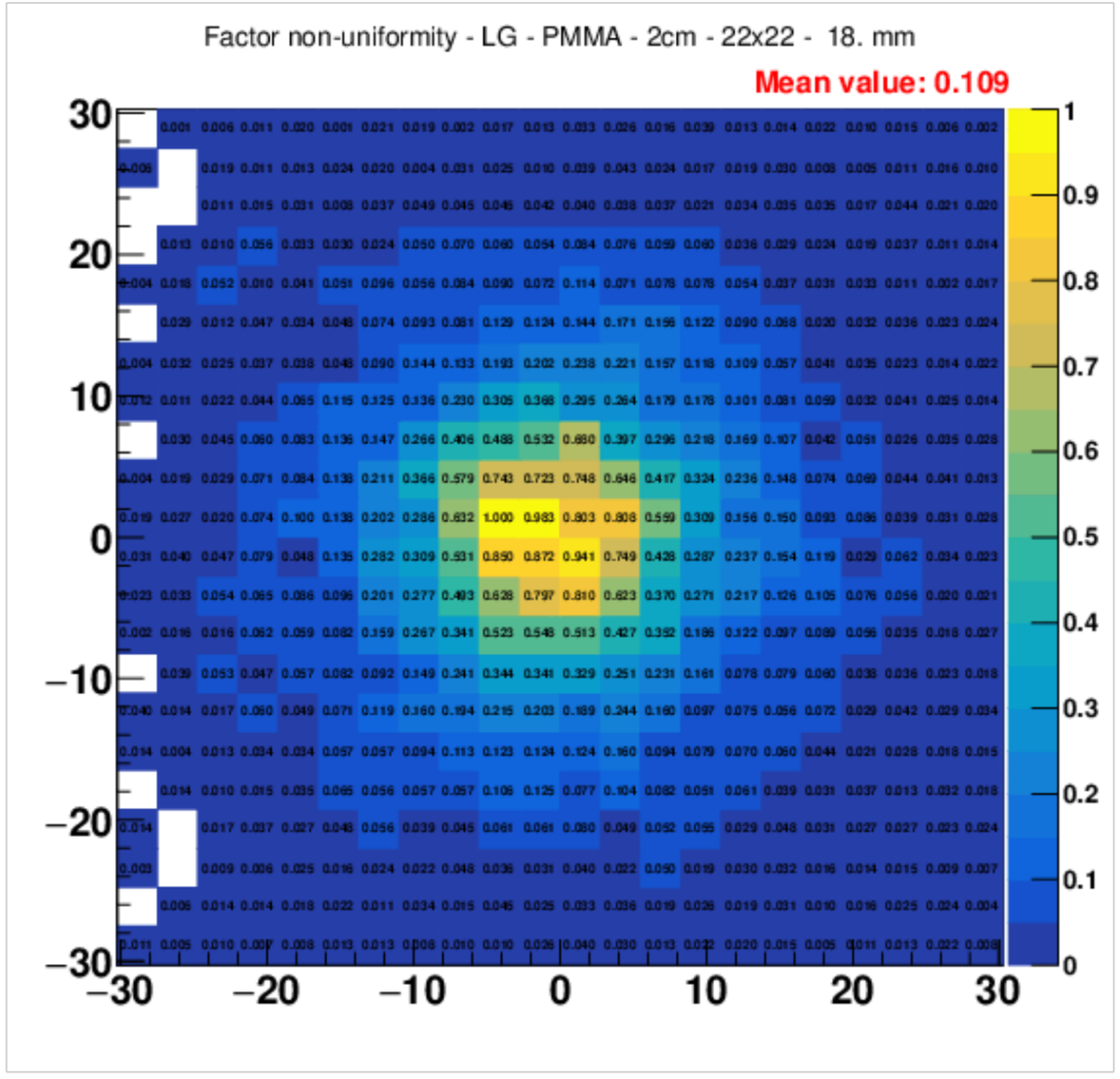


• Geometry 6 PMMA

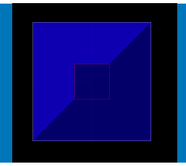


22x22 — Trap — 18 mm

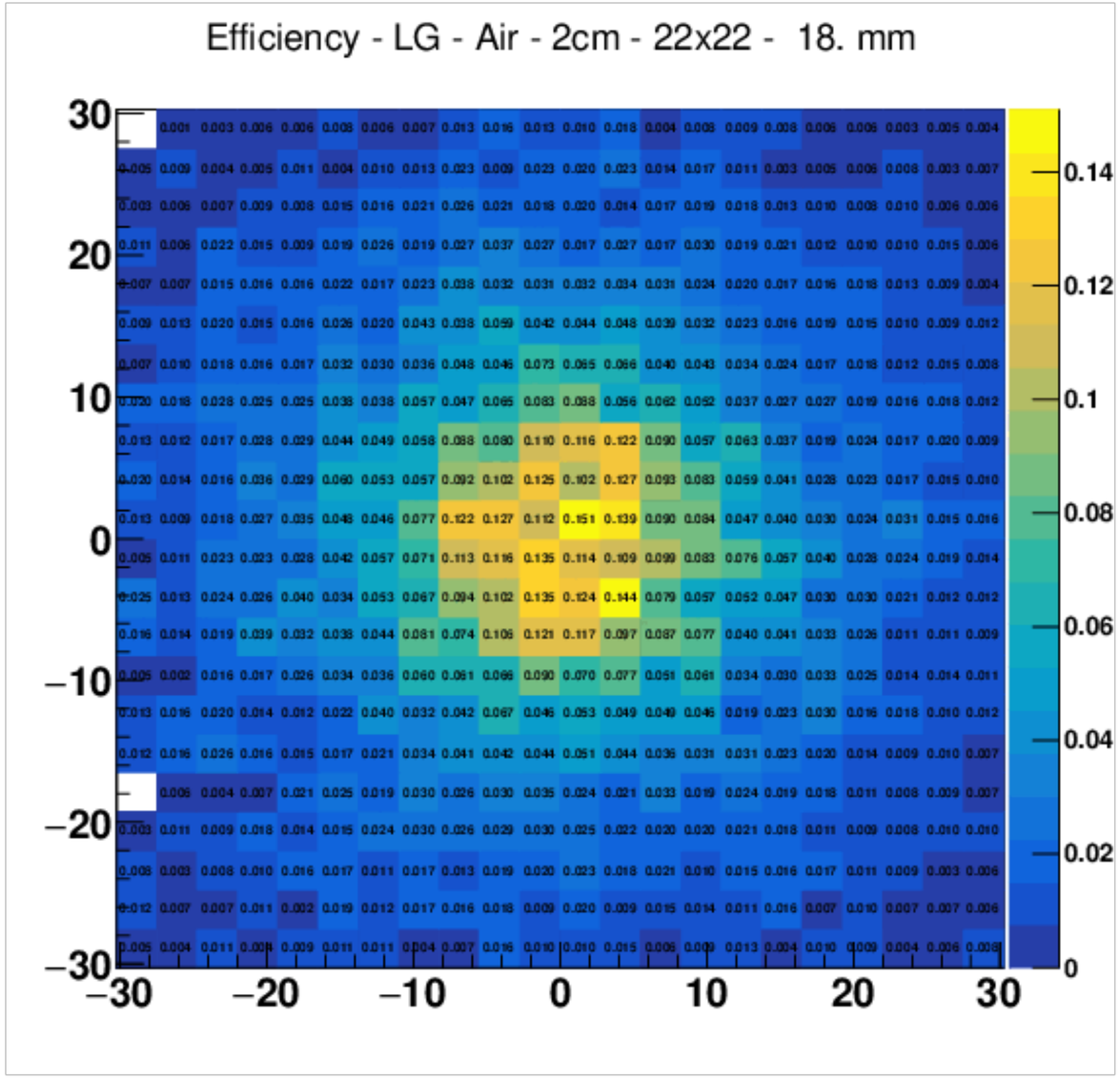


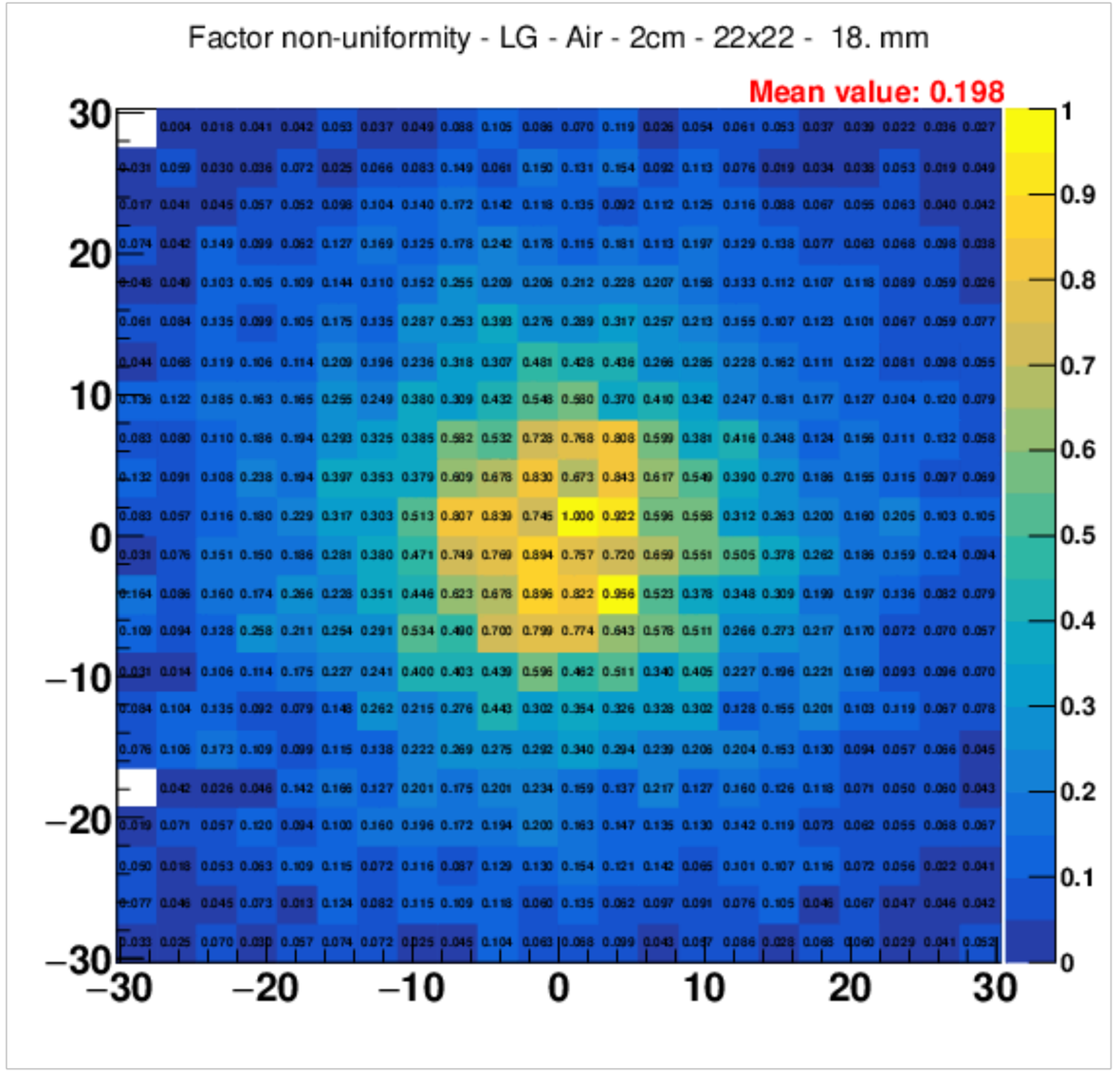


• Geometry 6 AIR



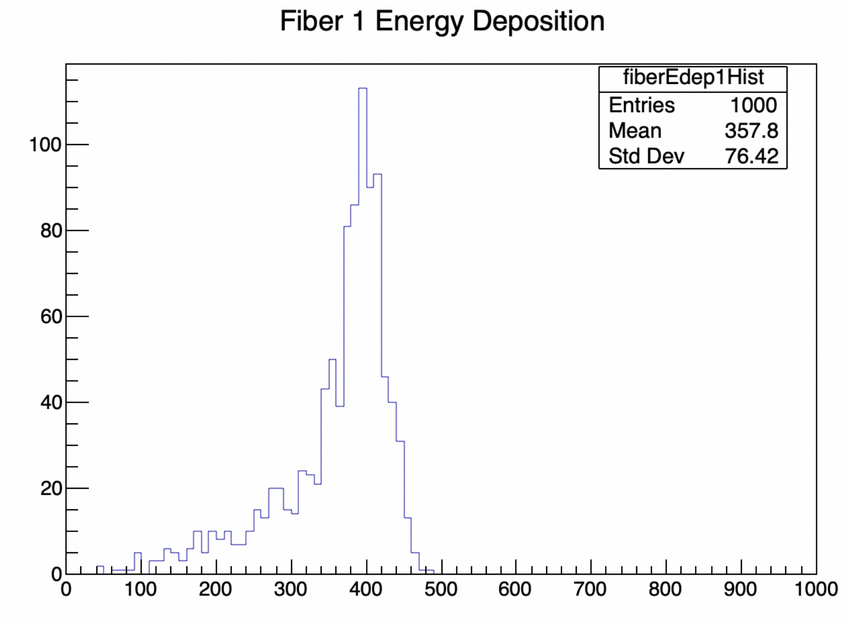
22x22 — Trap — 18 mm

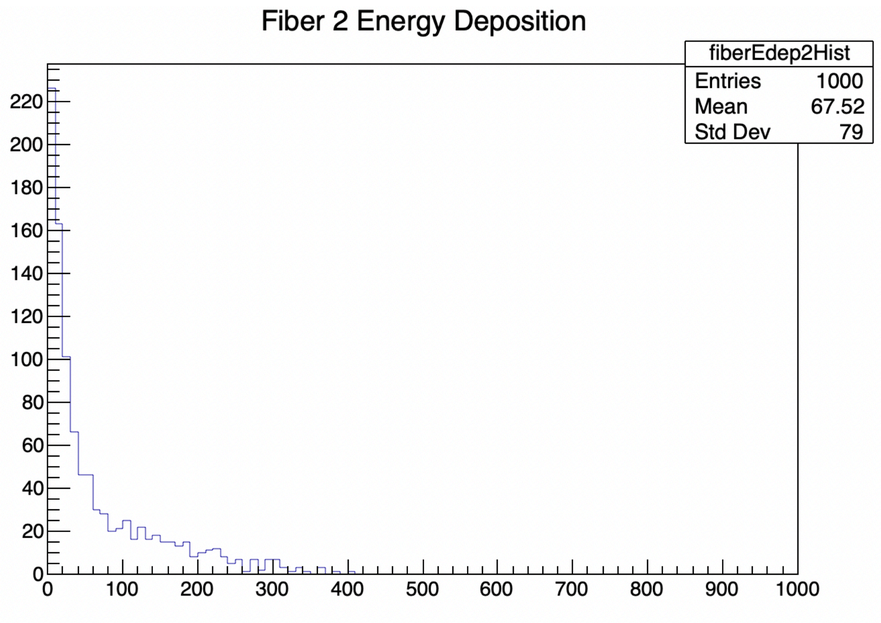




old slides

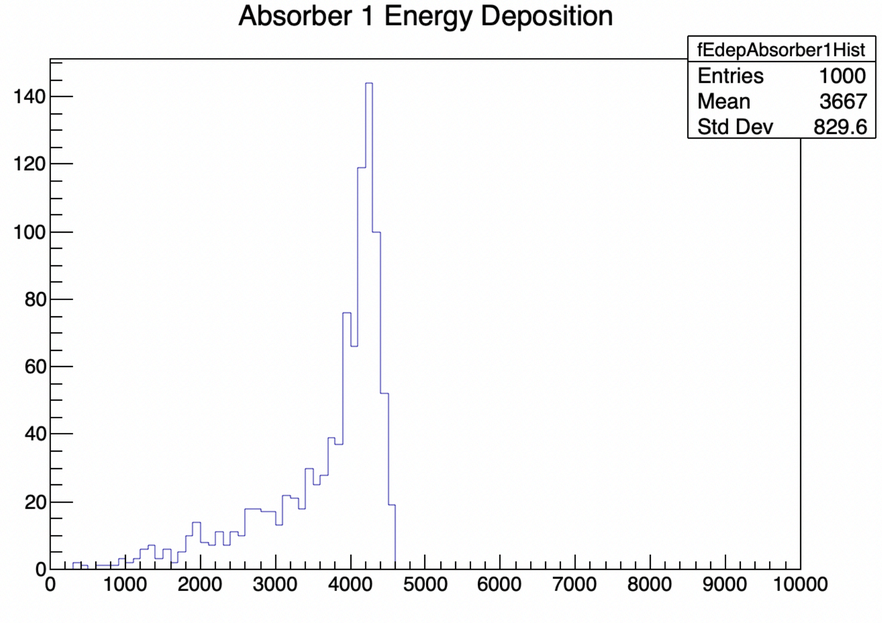
количество

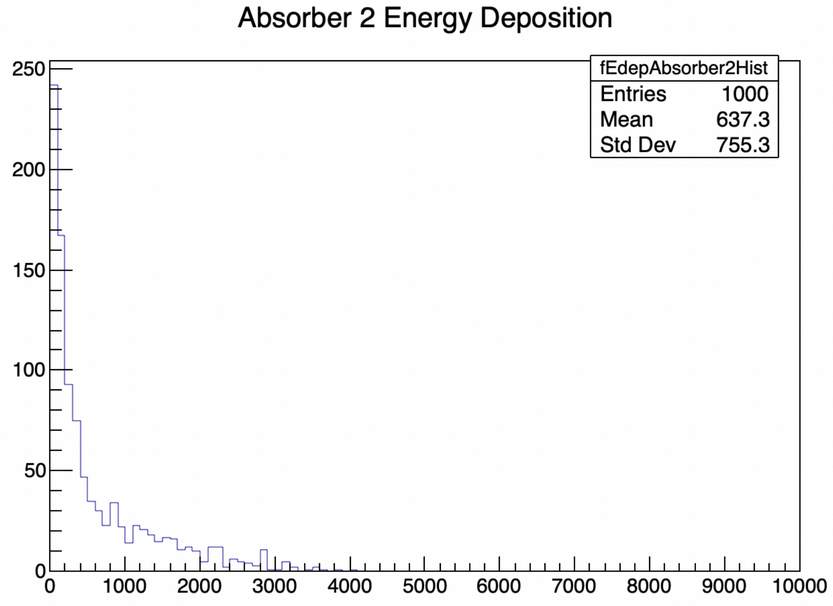


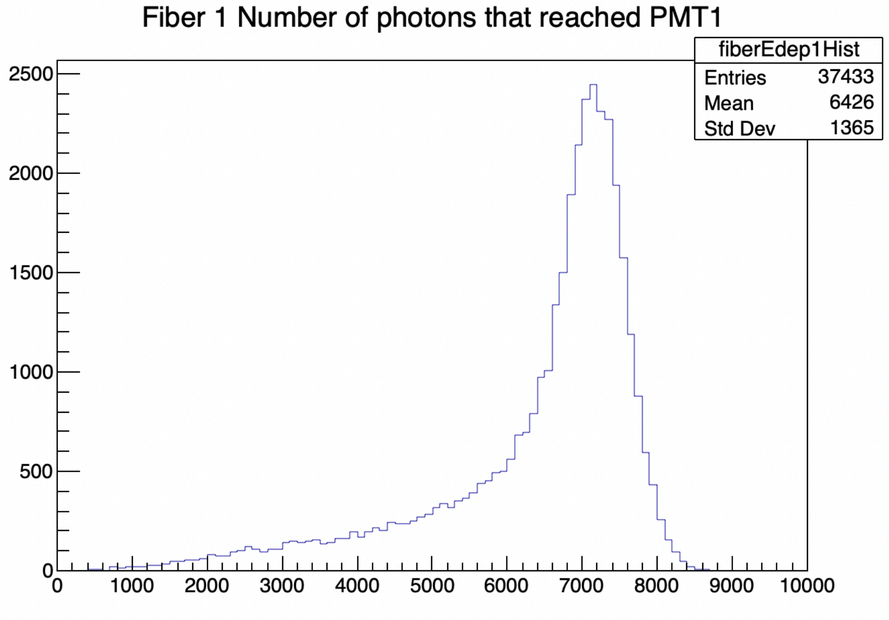


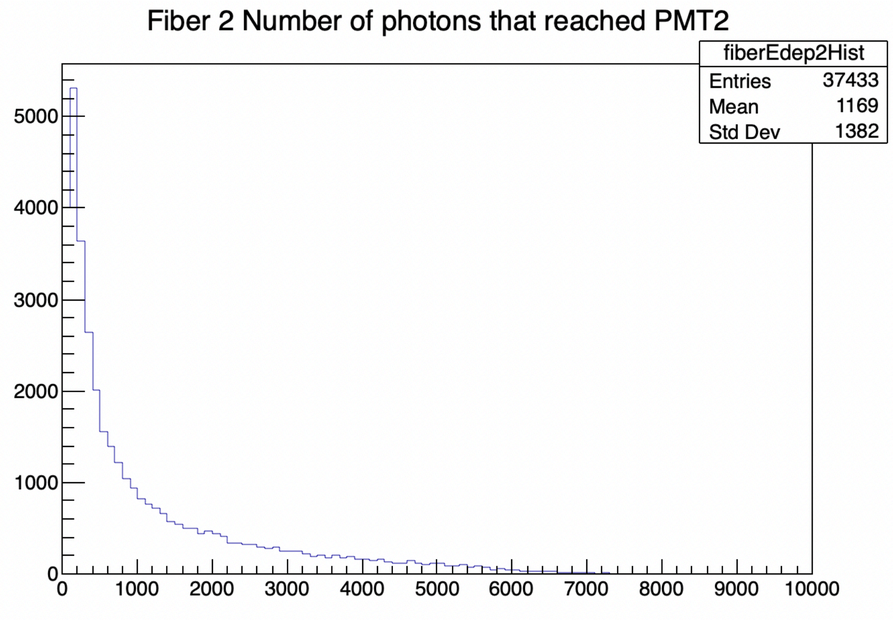
electrons
pions

10 GeV electron

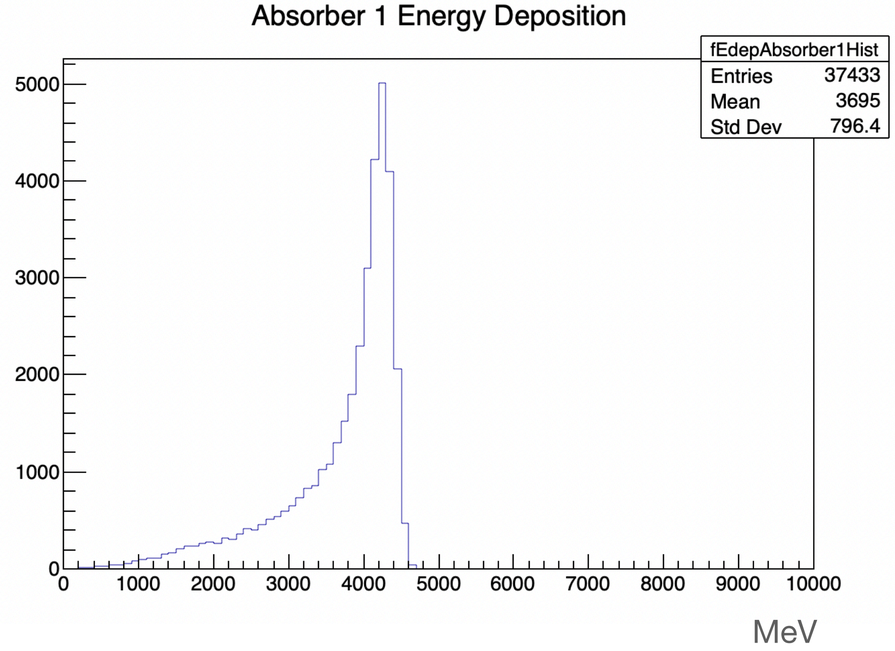


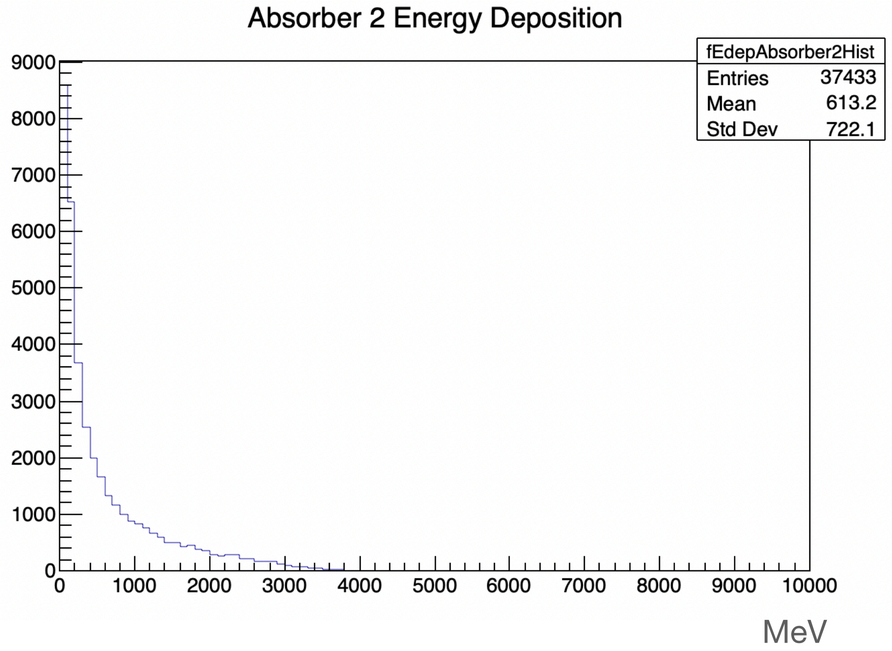


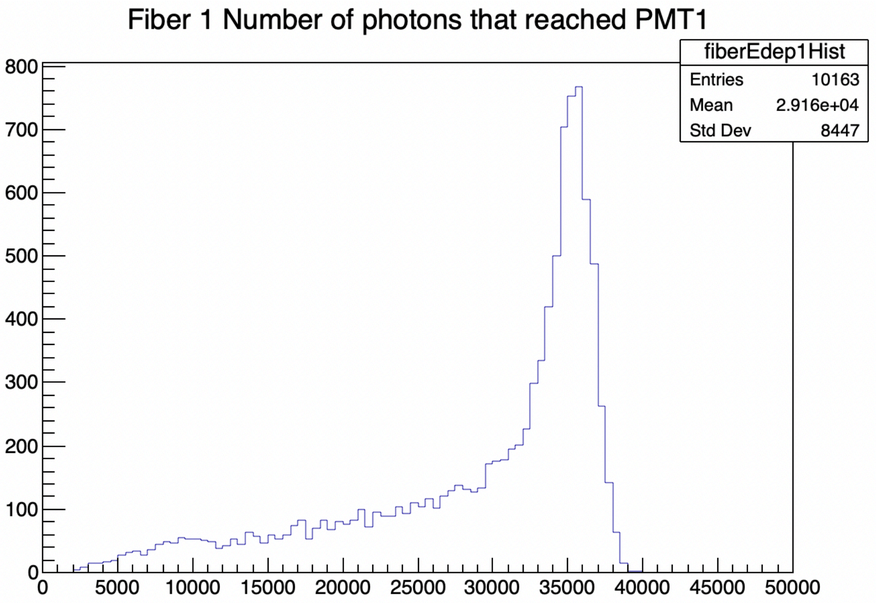


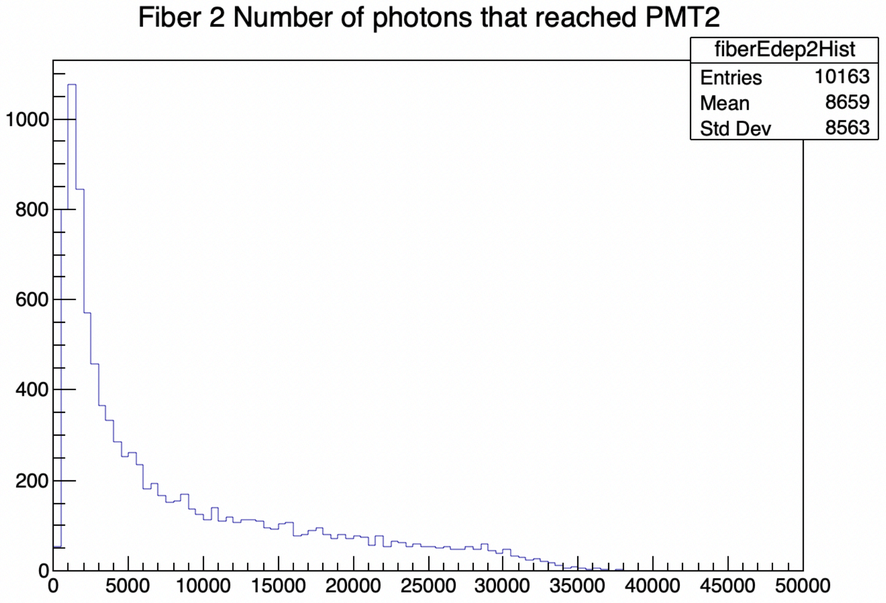


10 GeV electron

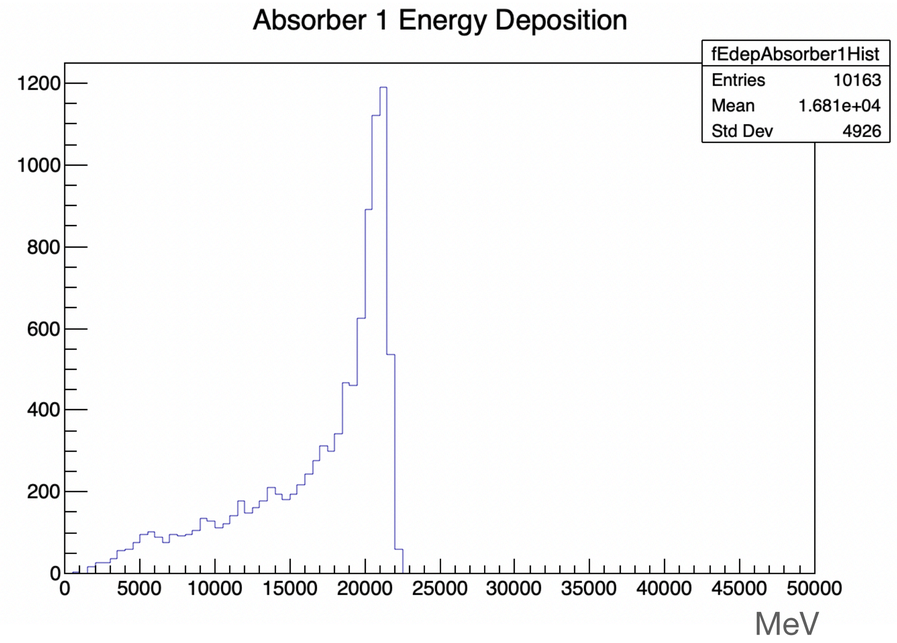


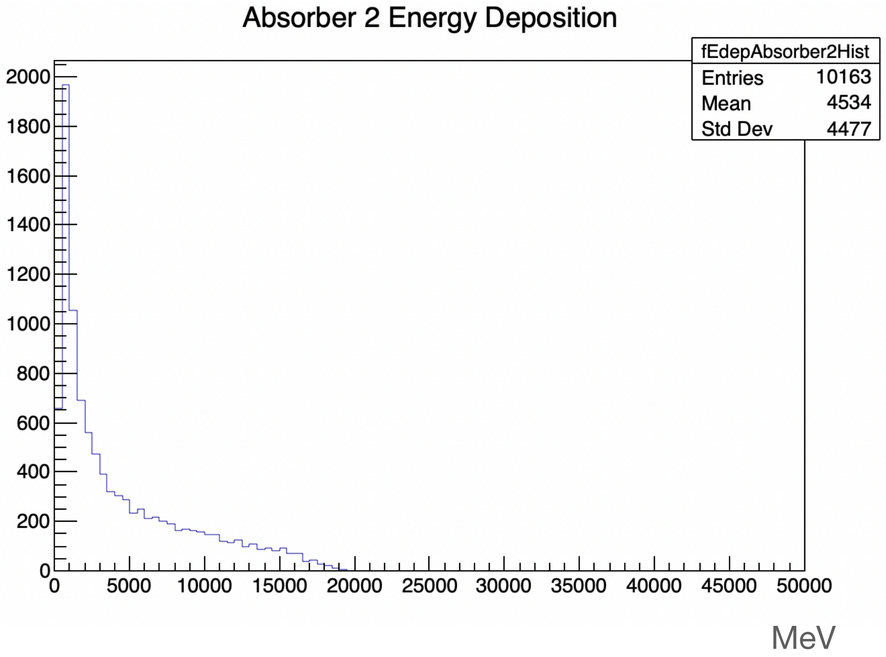




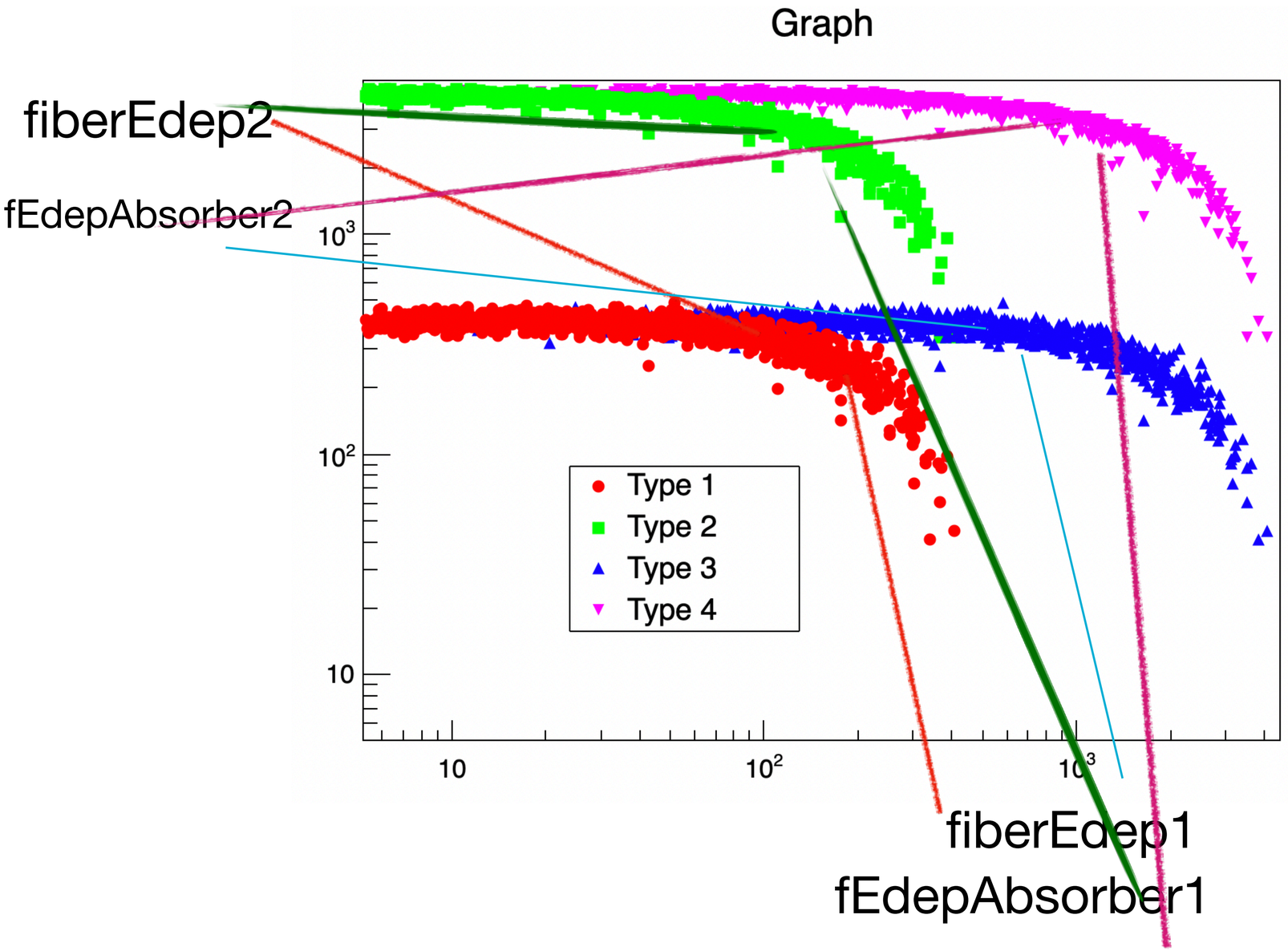


50 GeV electron





родившихся — дошедшие



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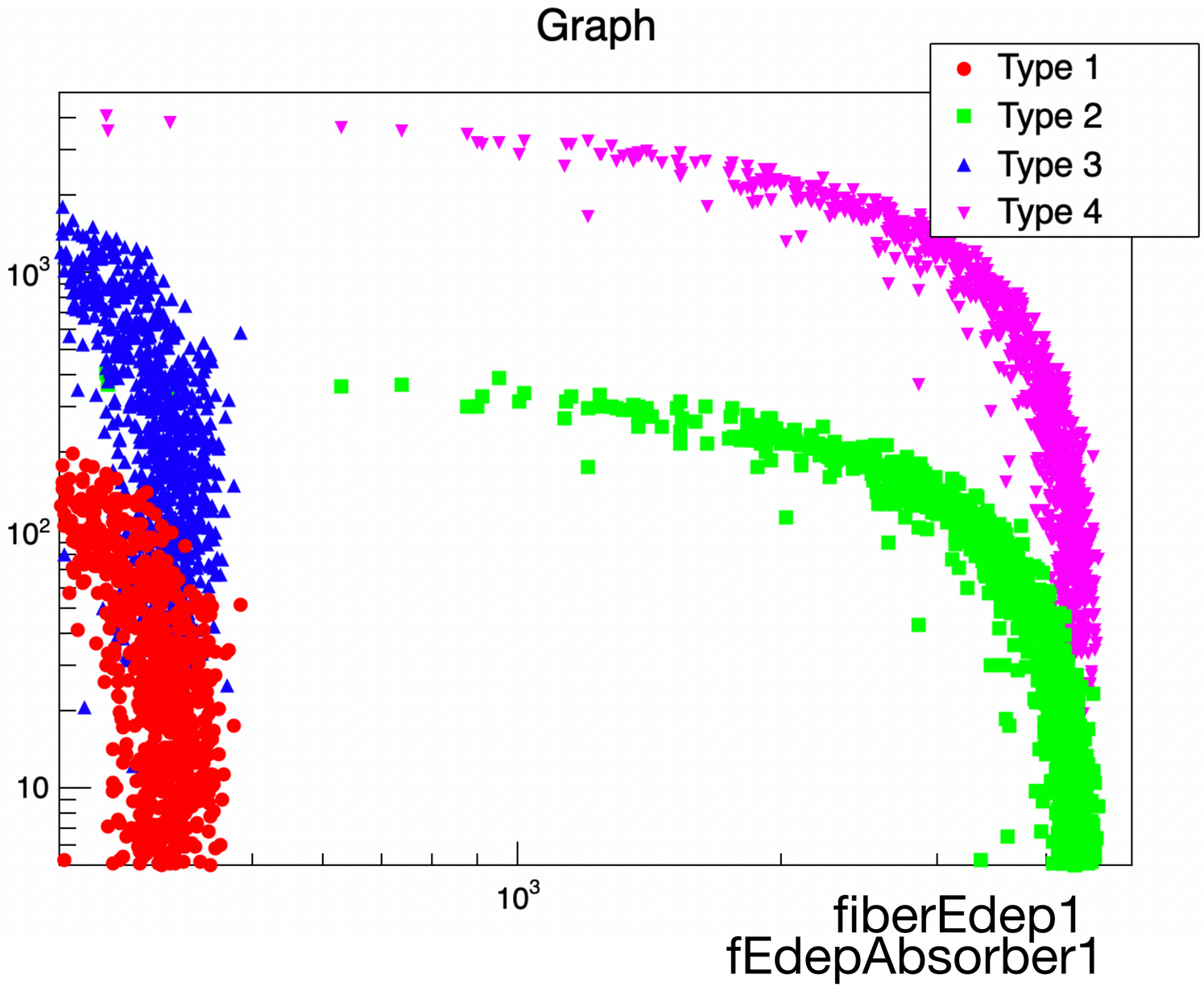
graph2>SetPoint(fEdepAbsorber1, fiberEdep2);

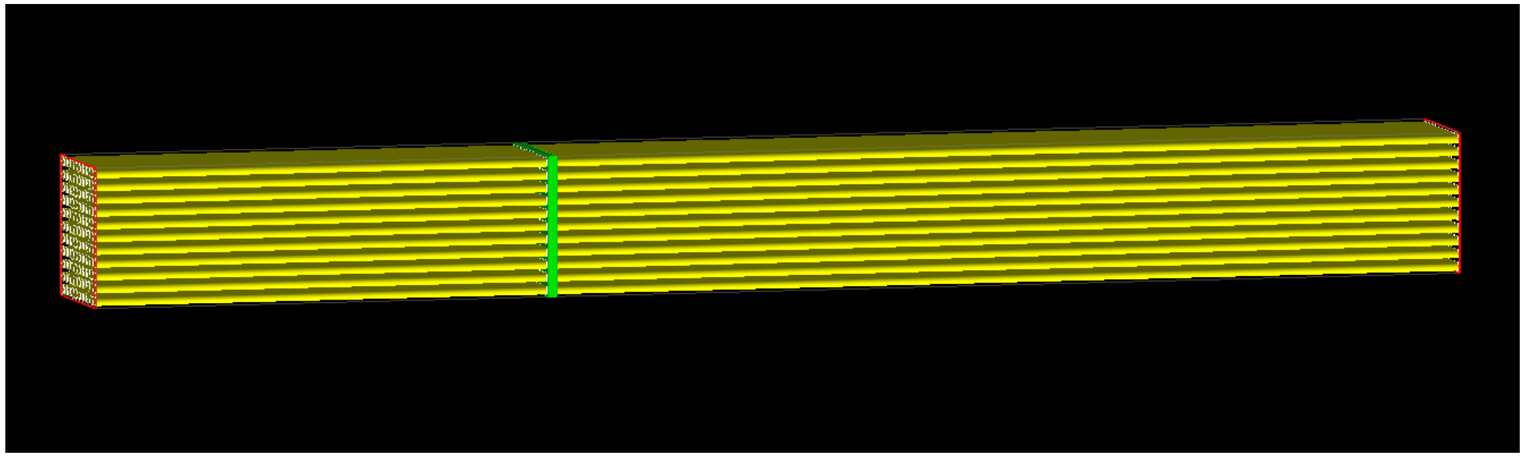
graph3>SetPoint(fiberEdep1, fEdepAbsorber2);

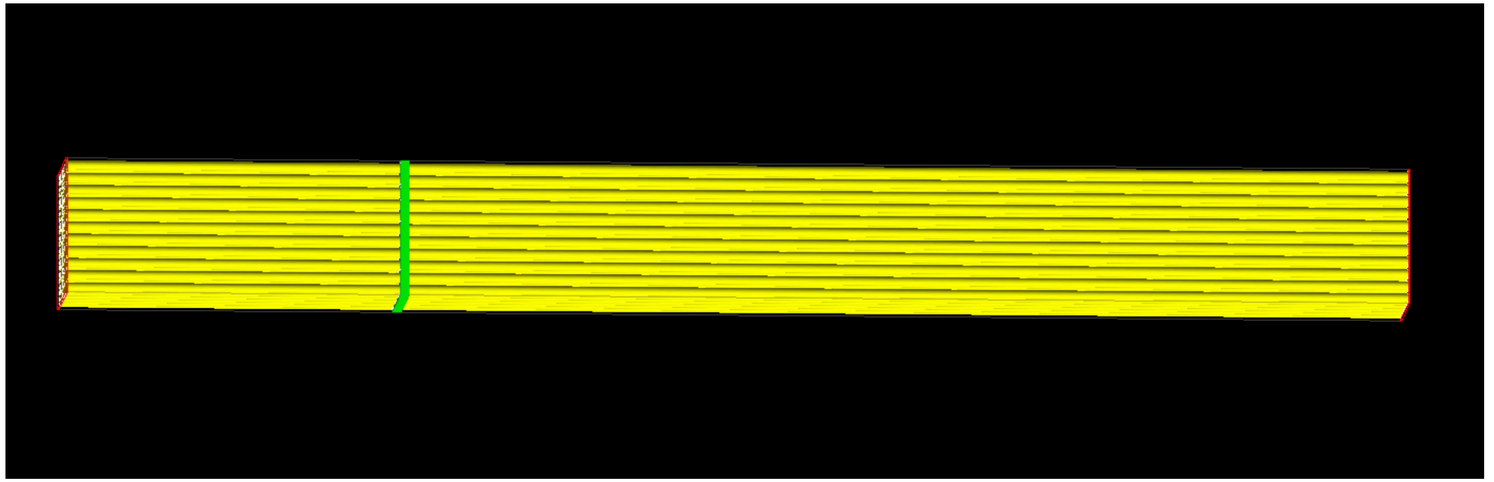
graph4>SetPoint(fEdepAbsorber1, fEdepAbsorber2);

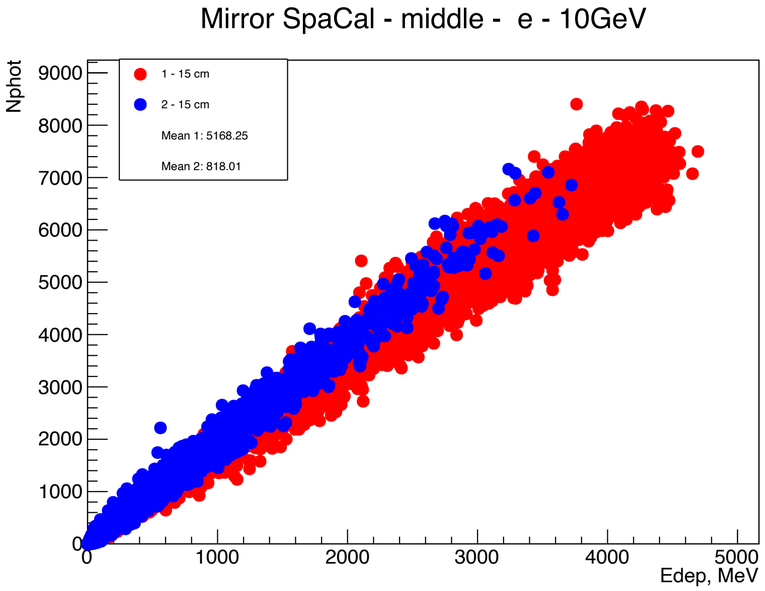
fiberEdep2

fEdepAbsorber2





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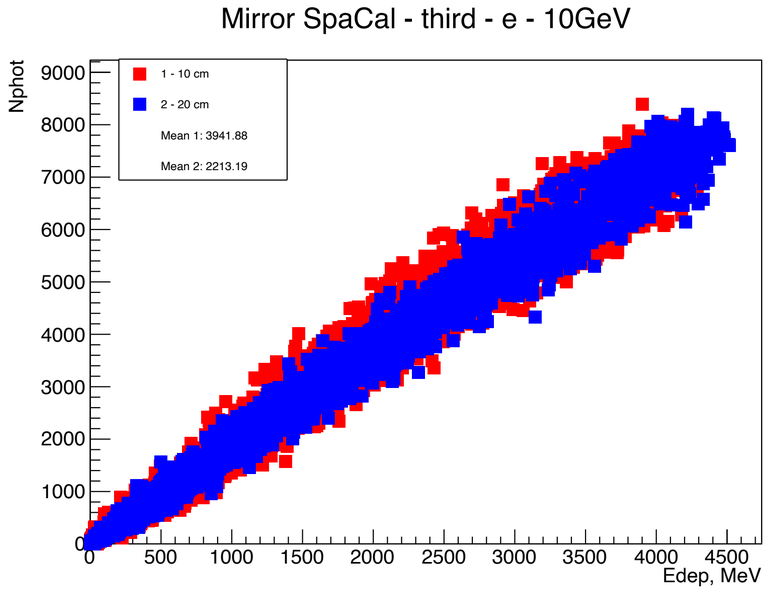
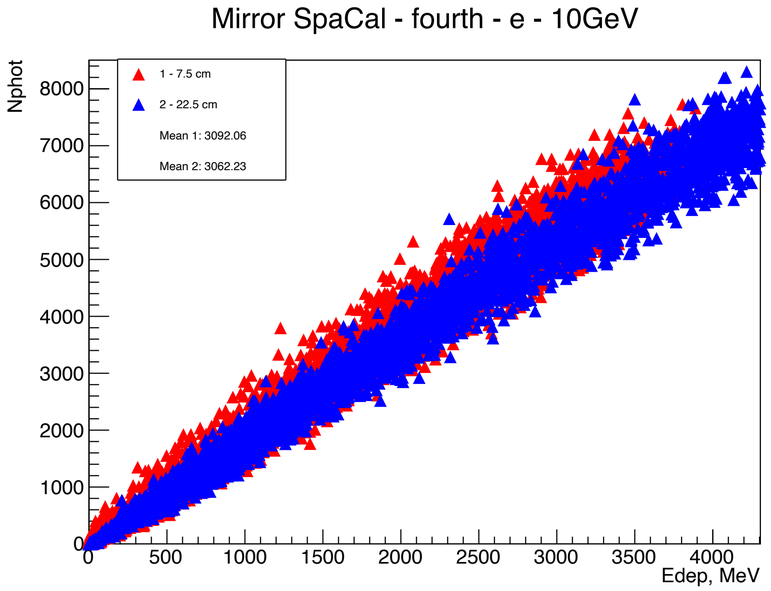
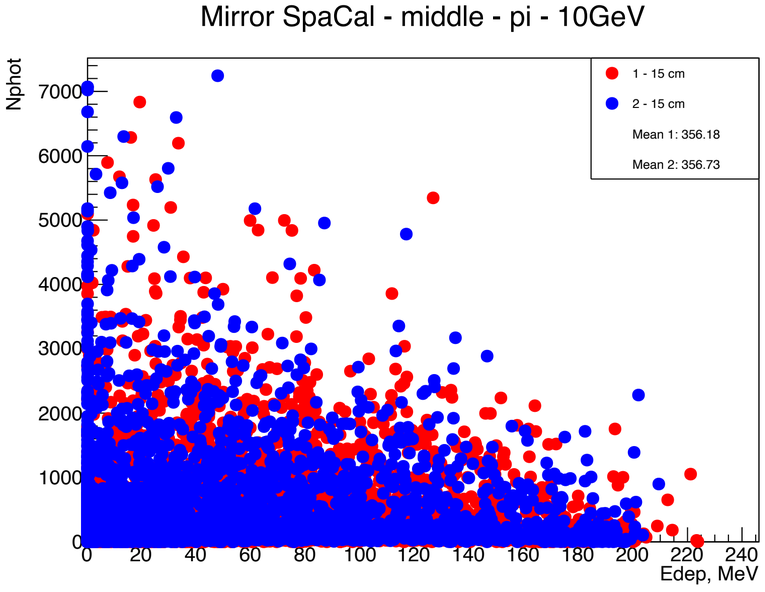
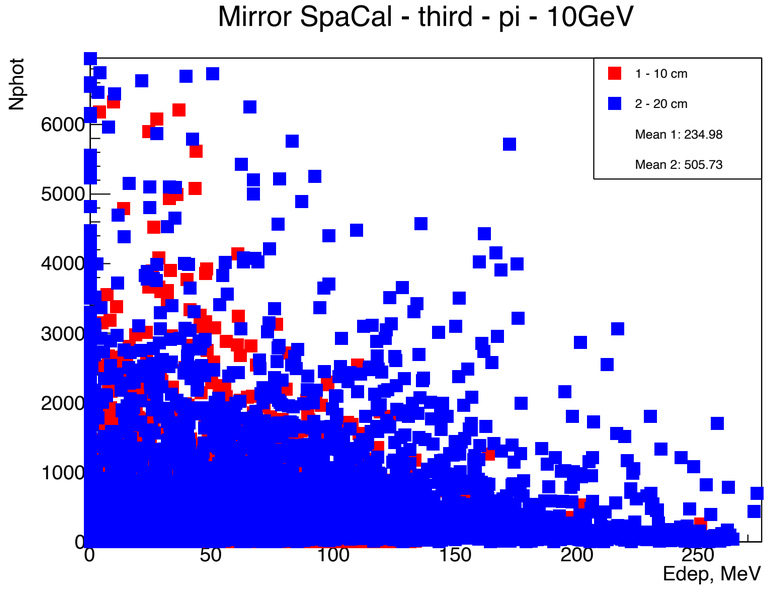
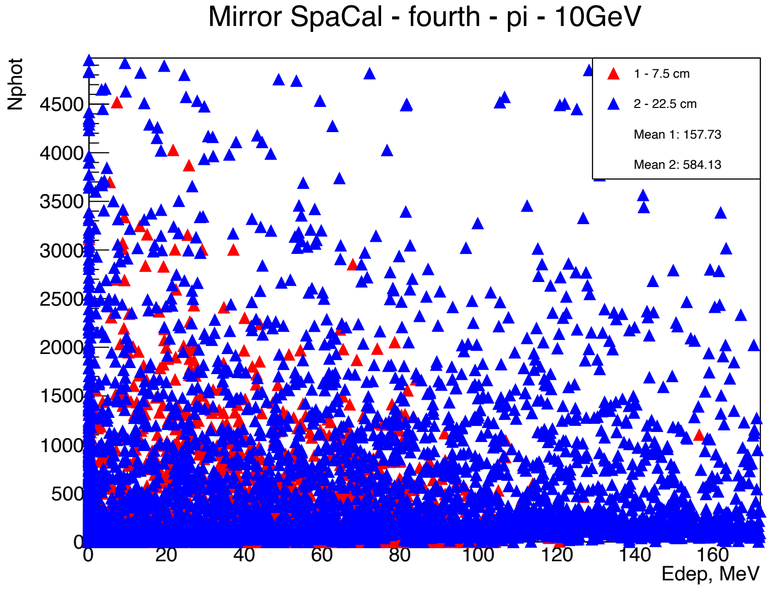
1 - 15 cm
2 - 15 cm
Mean 1: 5168.25
Mean 2: 818.01
Nphot
Edep, MeV

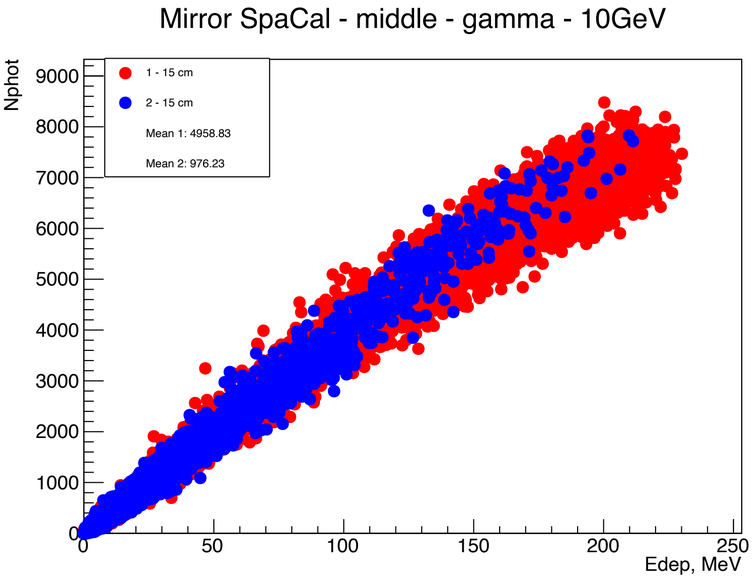

Mirror SpaCal - third - e - 10GeV
1 - 10 cm
2 - 20 cm
Mean 1: 3941.88
Mean 2: 2213.19
Nphot
Edep, MeV

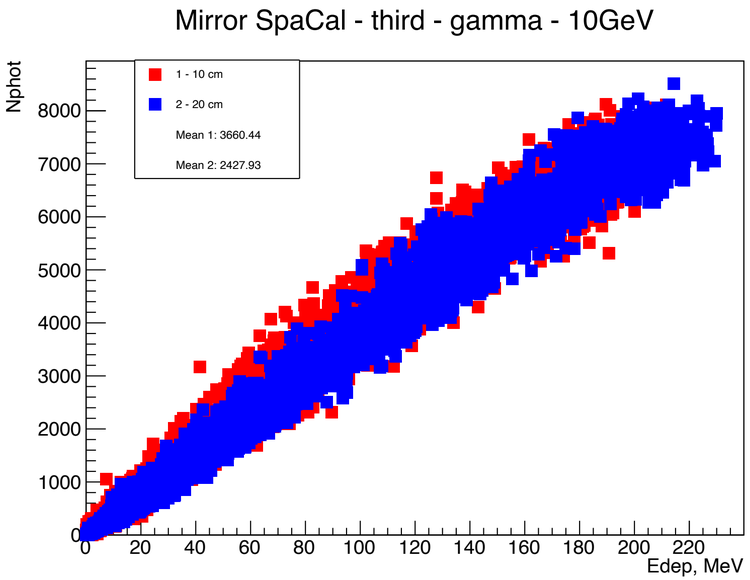

Mirror SpaCal - fourth - e - 10GeV
1 - 7.5 cm
2 - 22.5 cm
Mean 1: 3092.06
Mean 2: 3062.23
Nphot
Edep, MeV

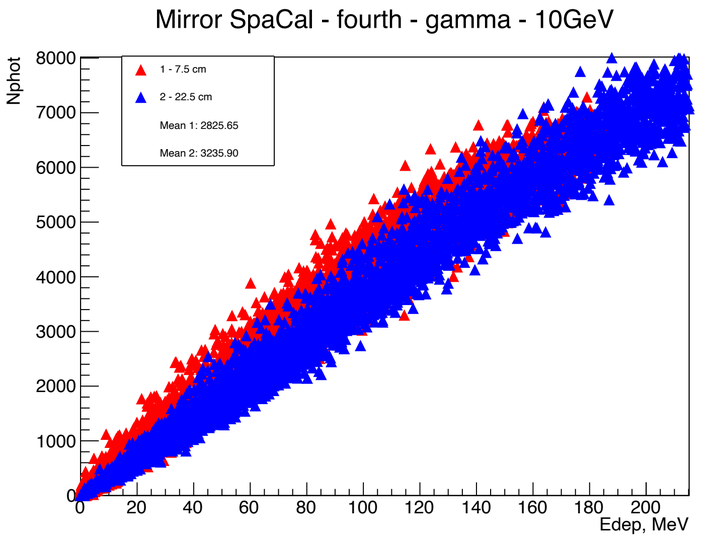

Mirror SpaCal - middle - pi - 10GeV
1 - 15 cm
2 - 15 cm
Mean 1: 356.18
Mean 2: 356.73
Nphot
Edep, MeV

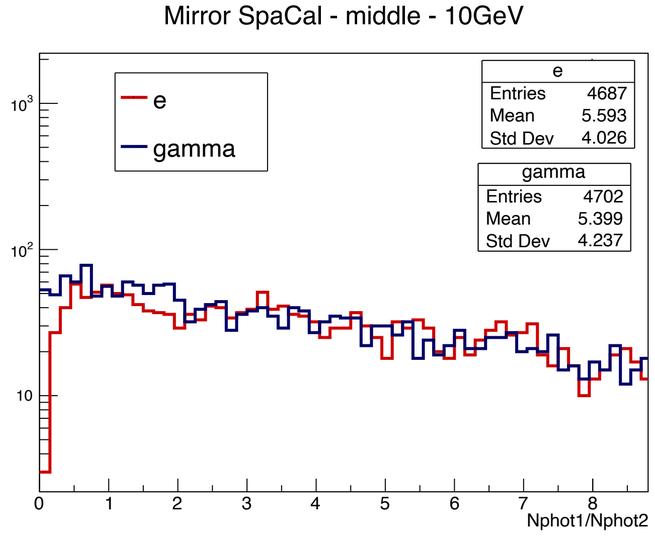

Mirror SpaCal - third - pi - 10GeV
1 - 10 cm
2 - 20 cm
Mean 1: 234.98
Mean 2: 505.73
Nphot
Edep, MeV

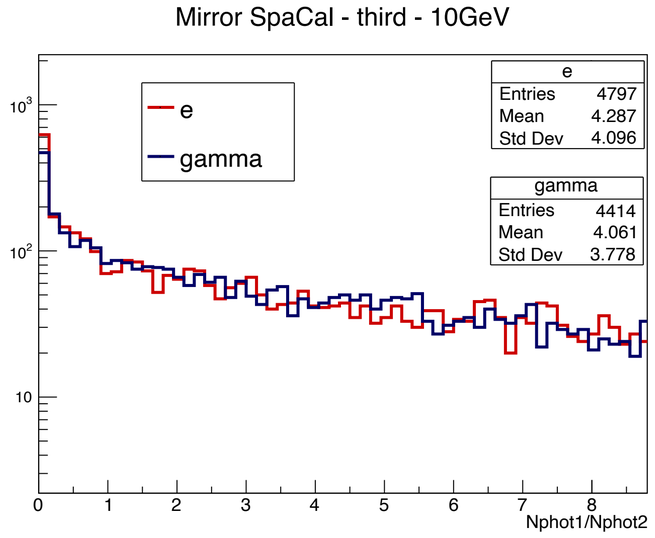

Mirror SpaCal - fourth - pi - 10GeV
1 - 7.5 cm
2 - 22.5 cm
Mean 1: 157.73
Mean 2: 584.13
Nphot
Edep, MeV

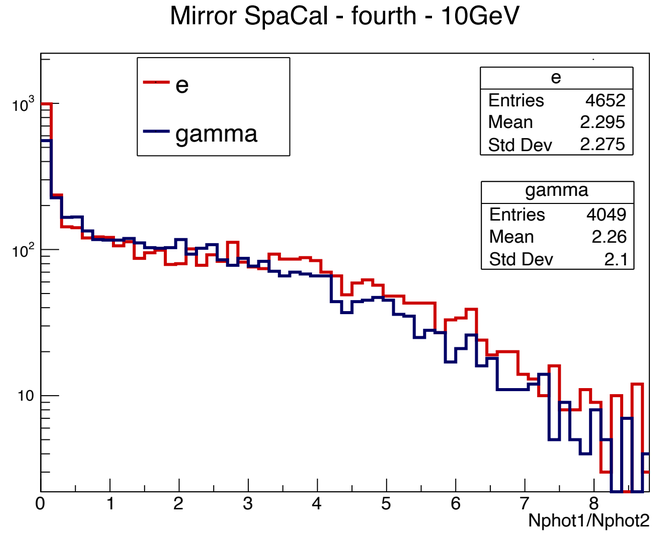

Mirror SpaCal - middle - gamma - 10GeV
1 - 15 cm
2 - 15 cm
Mean 1: 4958.83
Mean 2: 976.23
Nphot
Edep, MeV

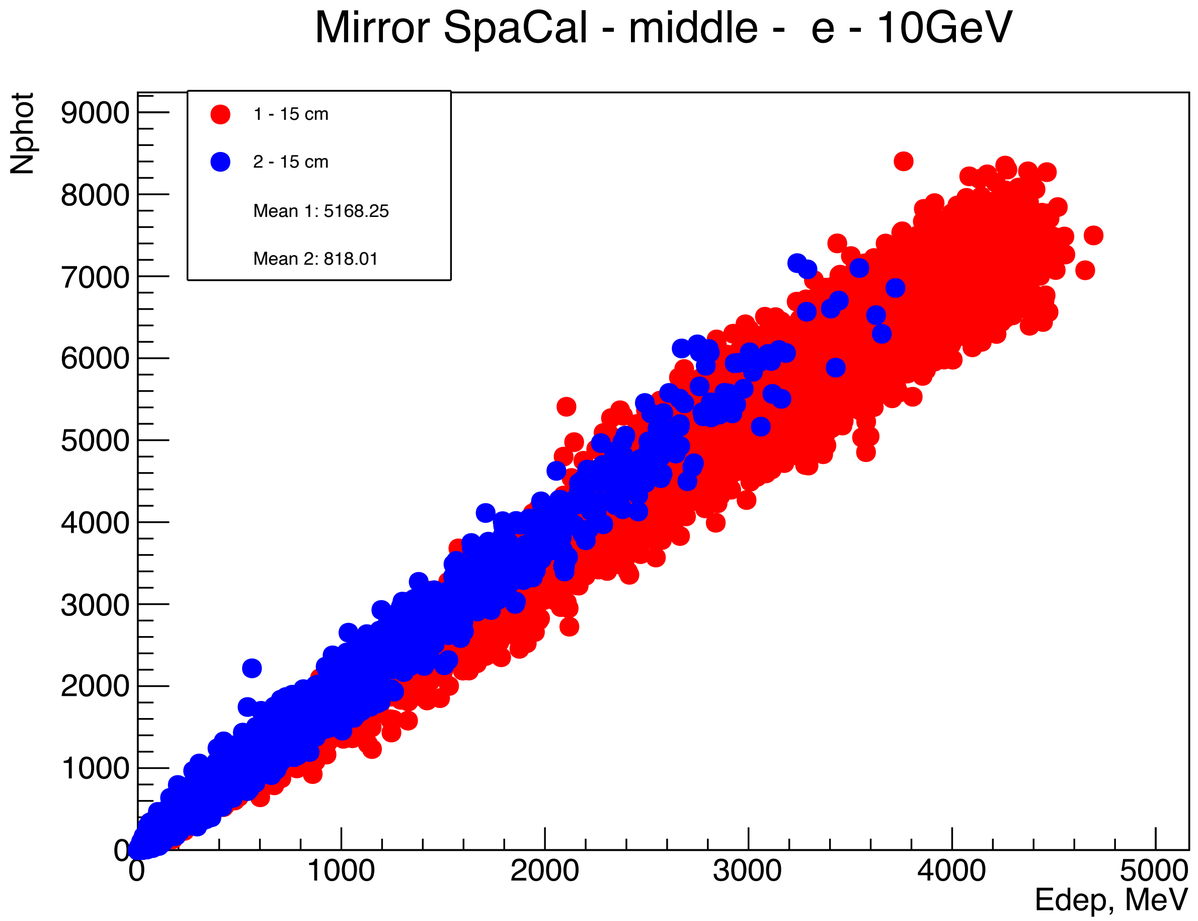

Mirror SpaCal - third - gamma - 10GeV
1 - 10 cm
2 - 20 cm
Mean 1: 3660.44
Mean 2: 2427.93
Nphot
Edep, MeV

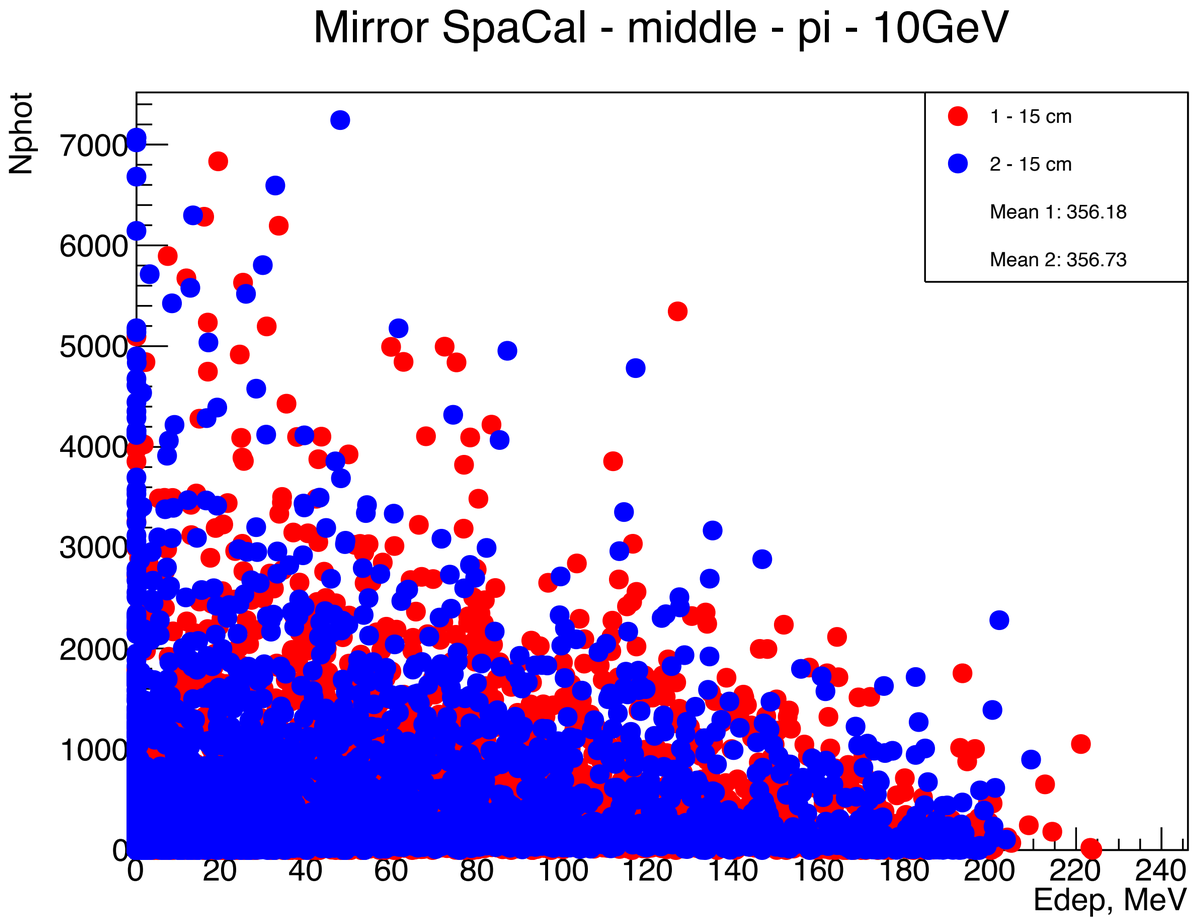

Mirror SpaCal - fourth - gamma - 10GeV
1 - 7.5 cm
2 - 22.5 cm
Mean 1: 2825.65
Mean 2: 3235.90
Nphot
Edep, MeV

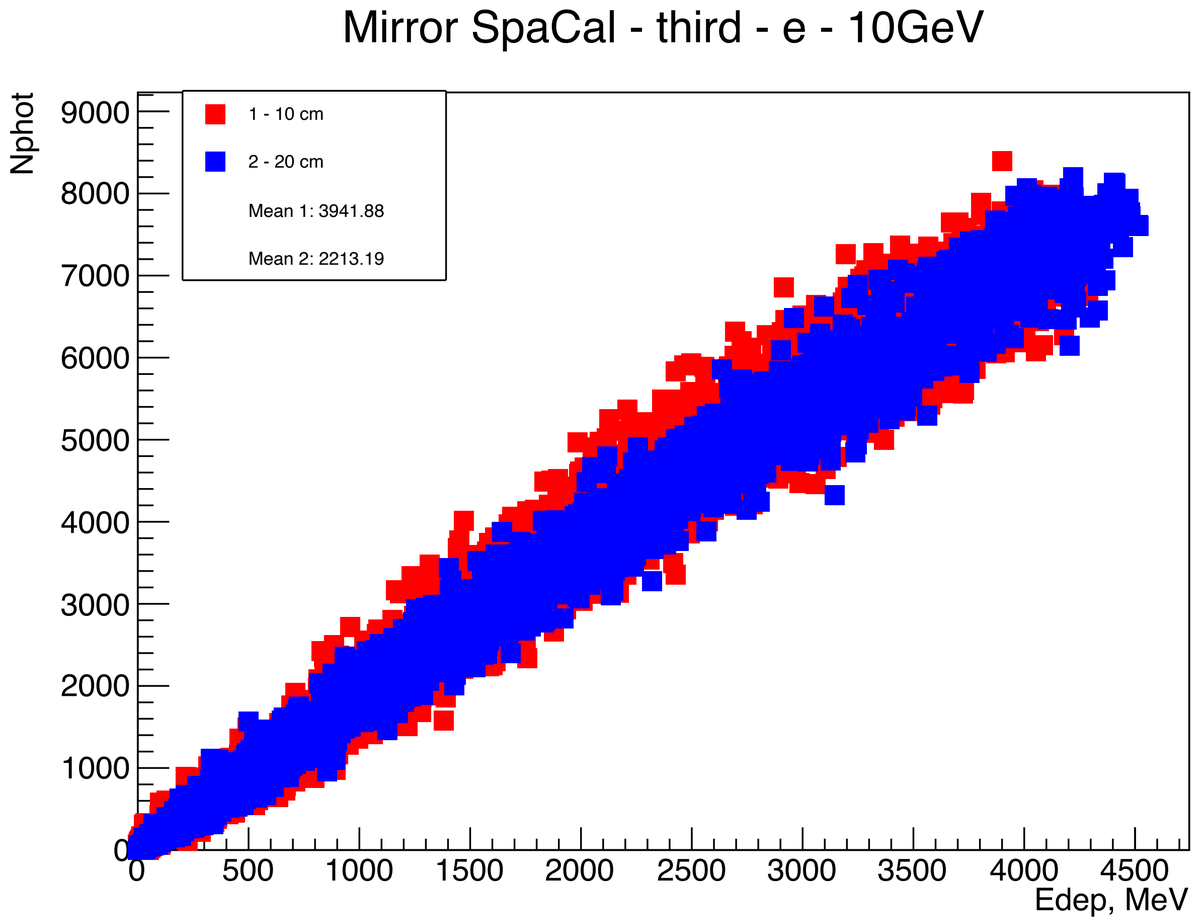

Mirror SpaCal - middle - 10GeV
e
gamma
e
Entries 4687
Mean 5.593
Std Dev 4.026
gamma
Entries 4702
Mean 5.399
Std Dev 4.237
Nphot1/Nphot2

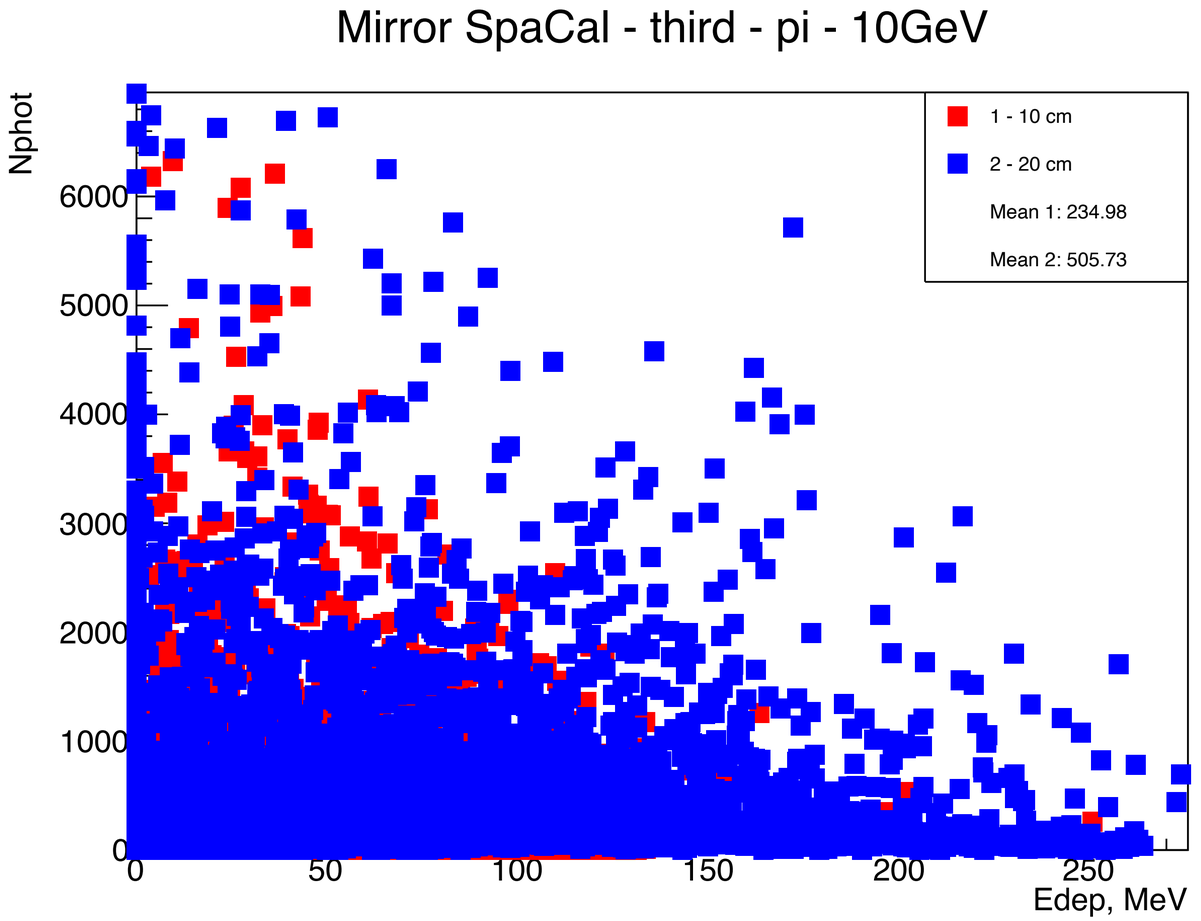

Mirror SpaCal - third - 10GeV
e
gamma
e
Entries 4797
Mean 4.287
Std Dev 4.096
gamma
Entries 4414
Mean 4.061
Std Dev 3.778
Nphot1/Nphot2

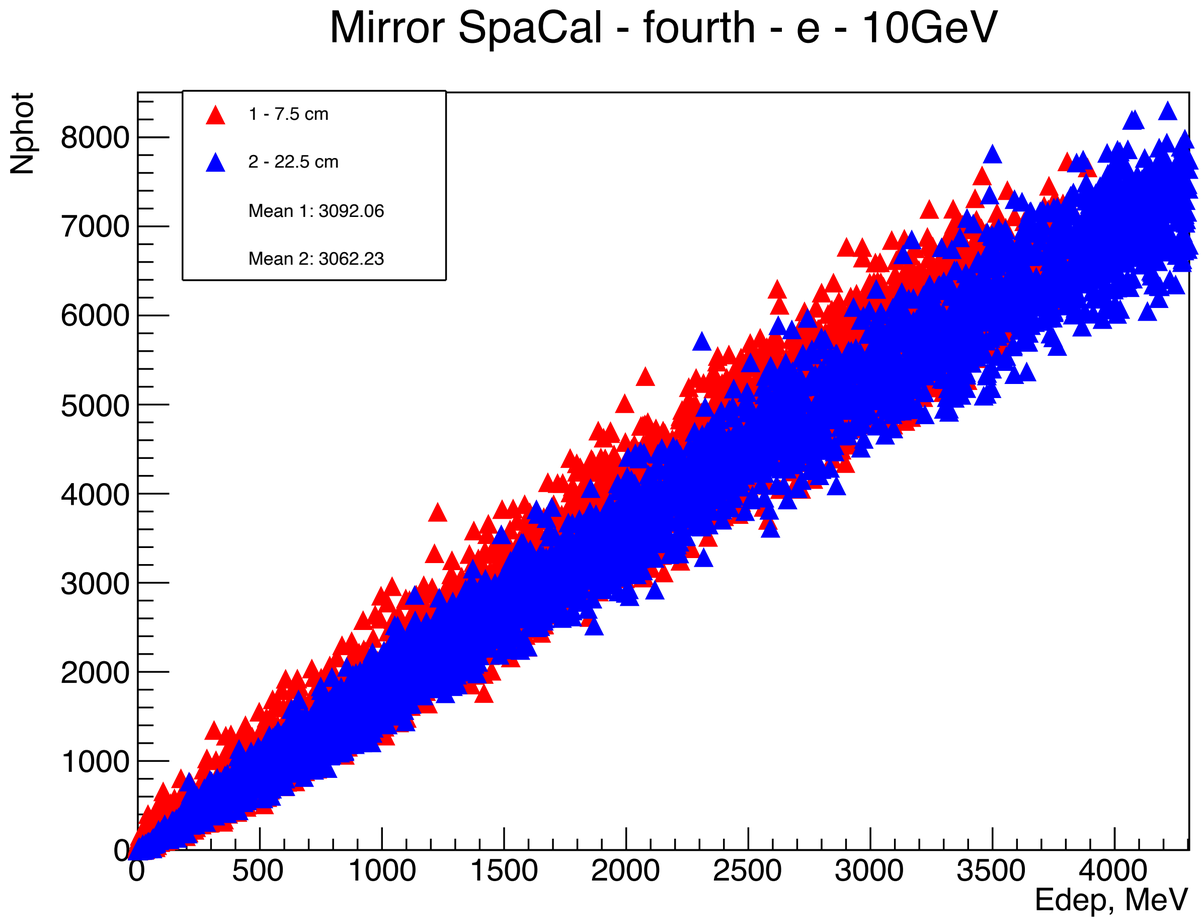

Mirror SpaCal - fourth - 10GeV
e
gamma
e
Entries 4652
Mean 2.295
Std Dev 2.275
gamma
Entries 4049
Mean 2.26
Std Dev 2.1
Nphot1/Nphot2

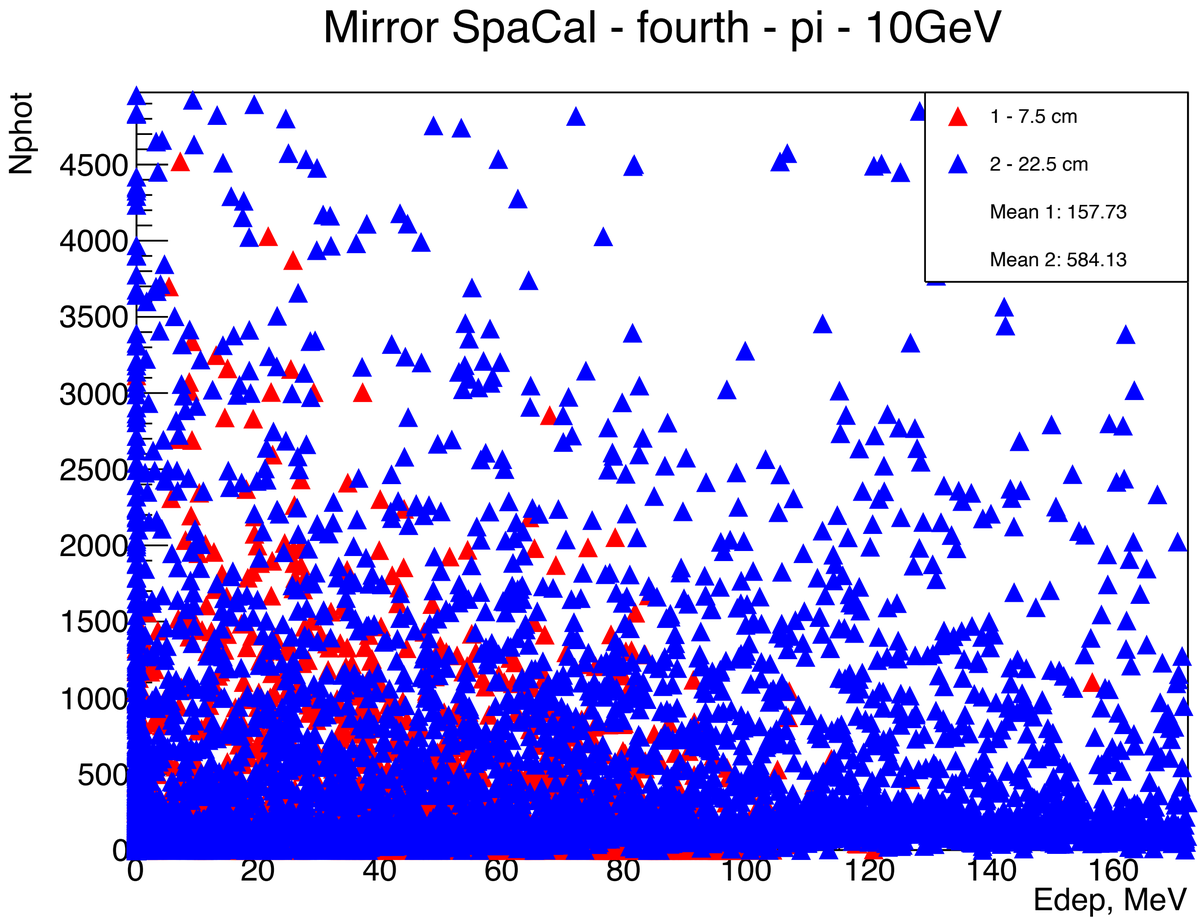

Mirror SpaCal - middle - e - 10GeV
Nphot
Edep, MeV
1 - 15 cm
2 - 15 cm
Mean 1: 5168.25
Mean 2: 818.01
0
1000
2000
3000
4000
5000
6000
7000
8000
9000

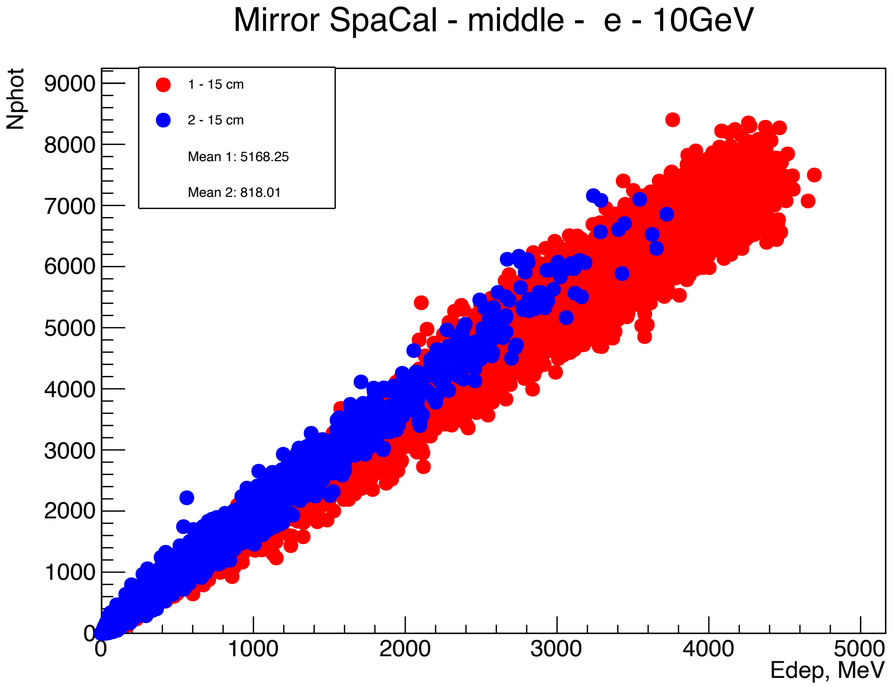

Mirror SpaCal - middle - pi - 10GeV
Nphot
Edep, MeV
1 - 15 cm
2 - 15 cm
Mean 1: 356.18
Mean 2: 356.73
0
1000
2000
3000
4000
5000
6000
7000
0
20
40
60
80
100
120
140
160
180
200
220
240

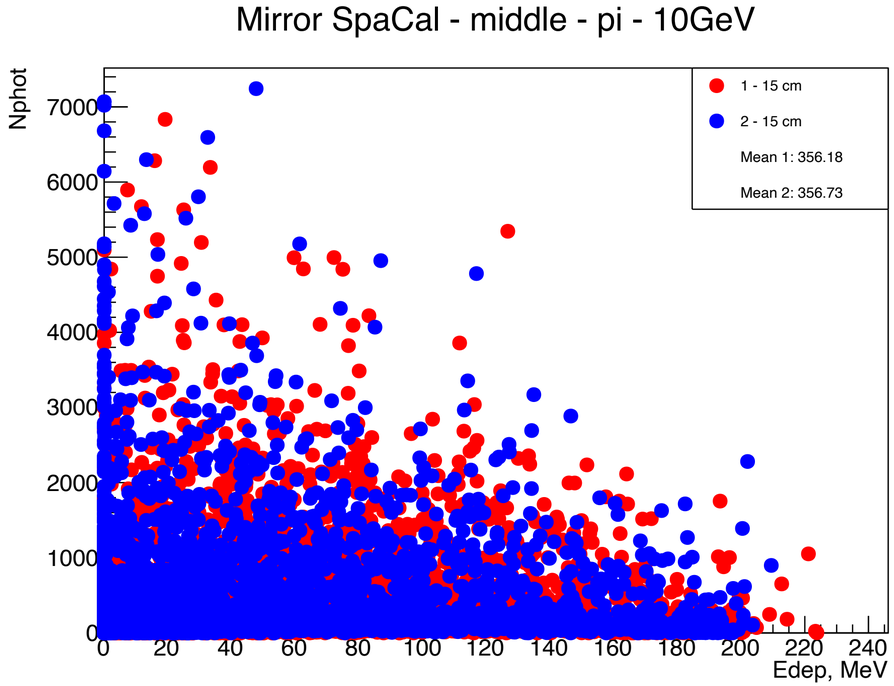

Mirror SpaCal - third - e - 10GeV
Nphot
Edep, MeV
1 - 10 cm
2 - 20 cm
Mean 1: 3941.88
Mean 2: 2213.19
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
0
500
1000
1500
2000
2500
3000
3500
4000
4500


Mirror SpaCal - third - pi - 10GeV
Nphot
Edep, MeV
1 - 10 cm
2 - 20 cm
Mean 1: 234.98
Mean 2: 505.73
0
1000
2000
3000
4000
5000
6000
0
50
100
150
200
250


Mirror SpaCal - fourth - e - 10GeV
Nphot
Edep, MeV
1 - 7.5 cm
2 - 22.5 cm
Mean 1: 3092.06
Mean 2: 3062.23
0
1000
2000
3000
4000
5000
6000
7000
8000
0
500
1000
1500
2000
2500
3000
3500
4000

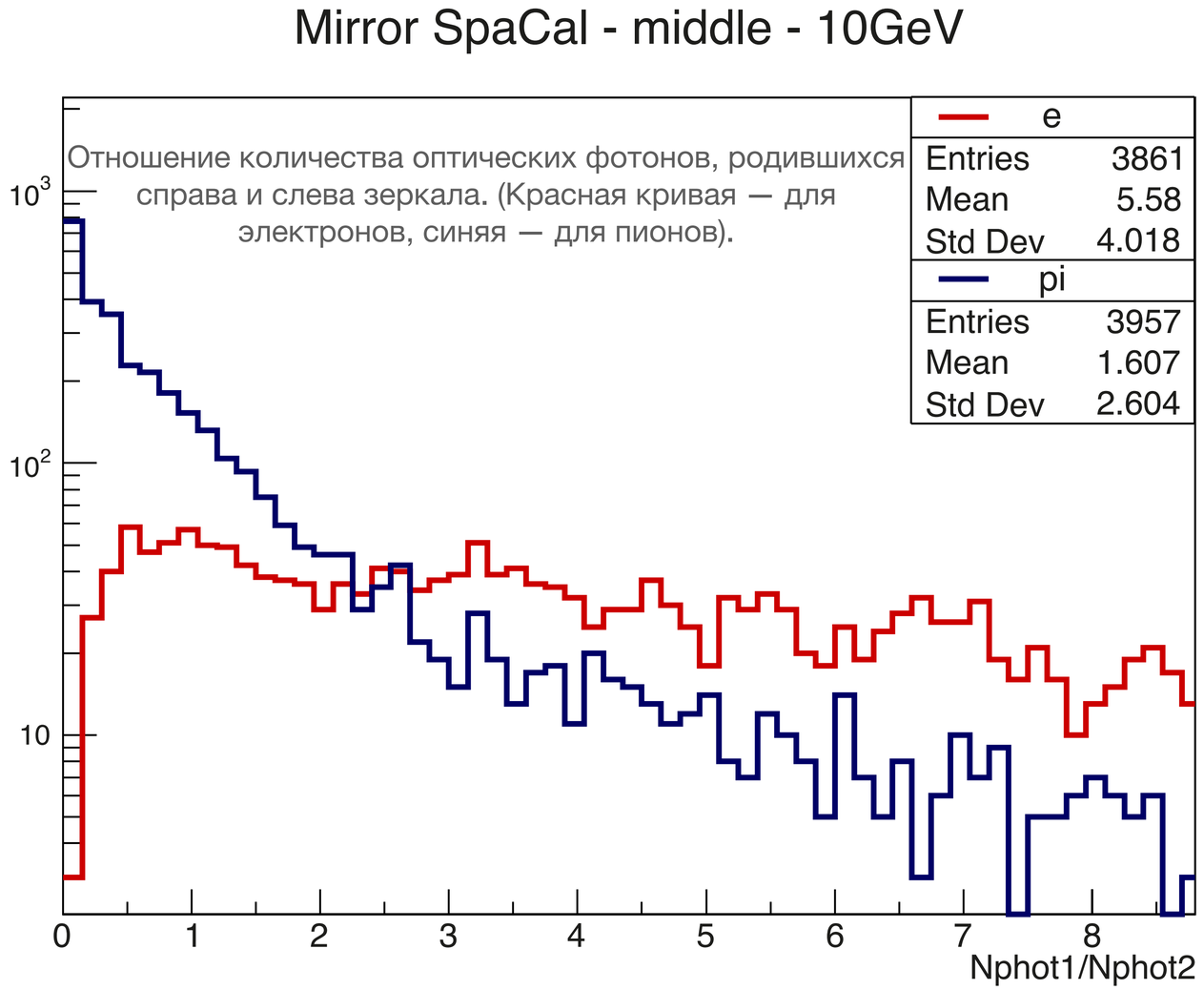

Mirror SpaCal - fourth - pi - 10GeV
Nphot
Edep, MeV
1 - 7.5 cm
2 - 22.5 cm
Mean 1: 157.73
Mean 2: 584.13
0
500
1000
1500
2000
2500
3000
3500
4000
4500
0
20
40
60
80
100
120
140
160



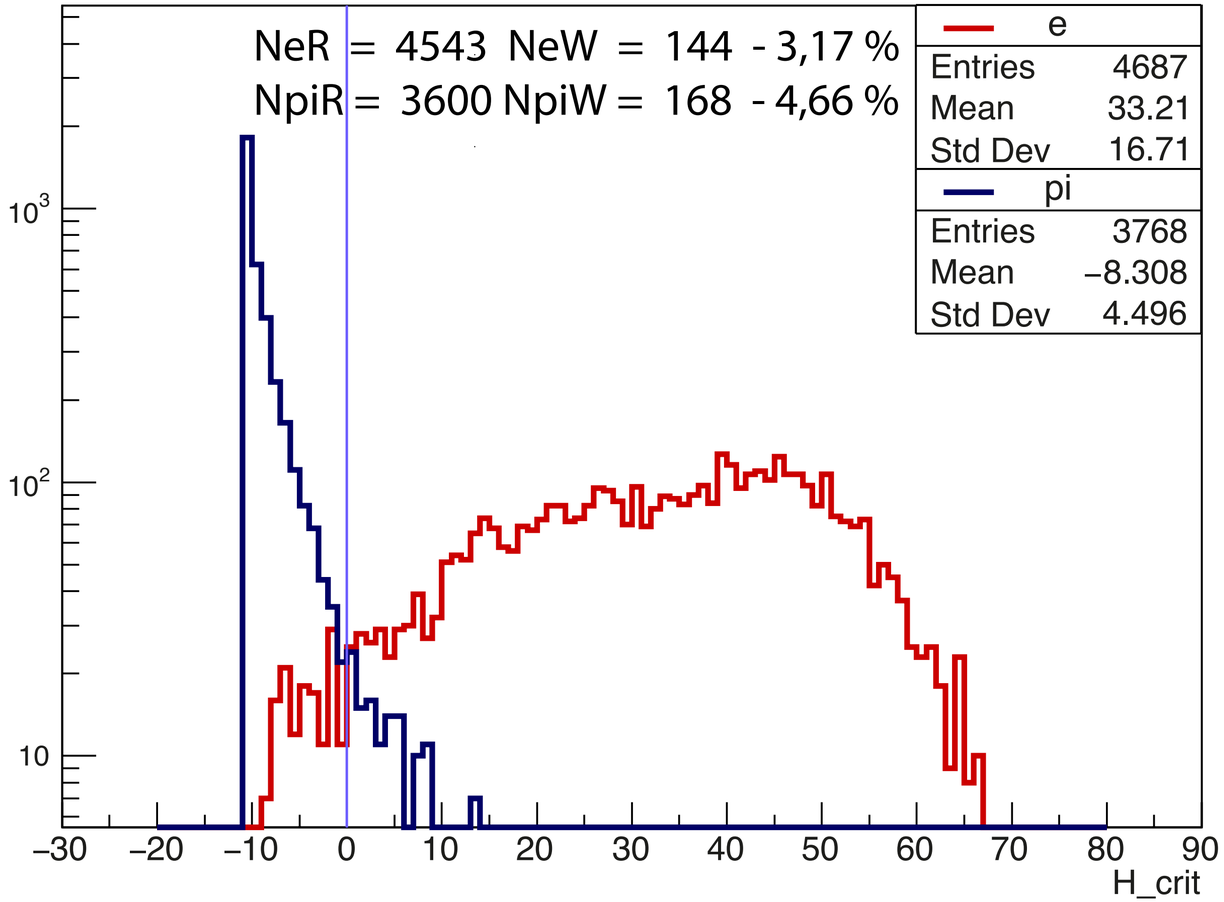


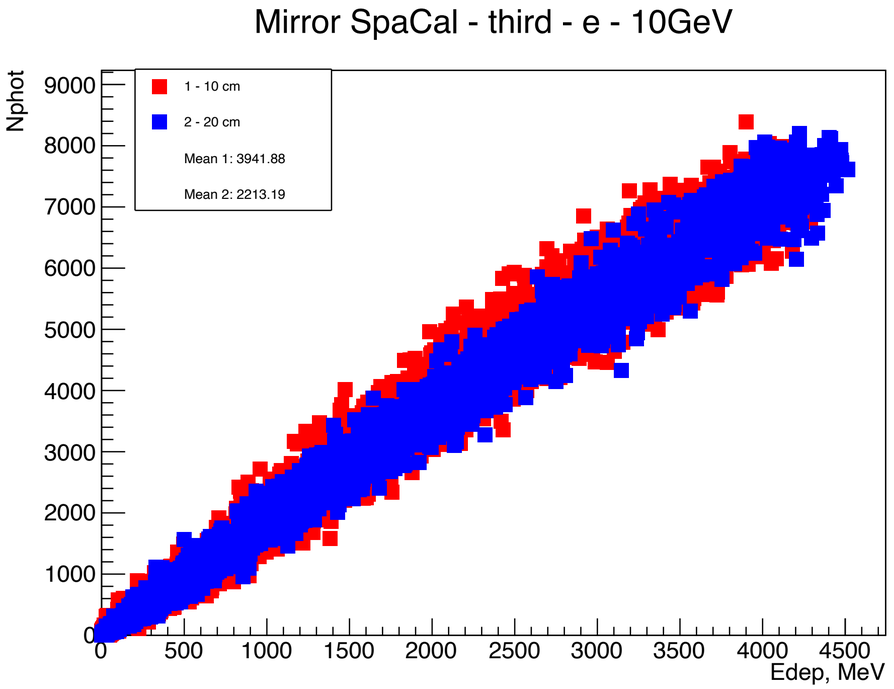
Распознавание электронов и пионов с помощью модуля SpaCal с зеркальным слоем.

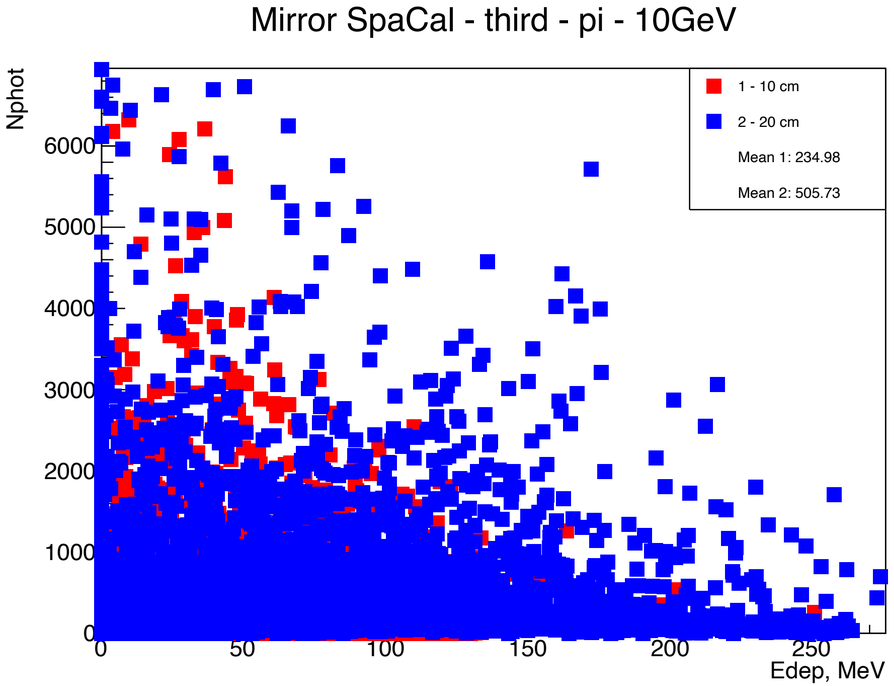
Расположение зеркала: середина —15см/15см.
Было брошено 5000 первичных электронов и пионов с энергией 10 ГэВ.
Точка входа частицы разыграна равномерно от -1,5 см до 1,5 см в плоскости xy.
Красные точки: энерговыделение и оптические фотоны до зеркала;
Синие точки: энерговыделение и оптические фотоны после зеркала.



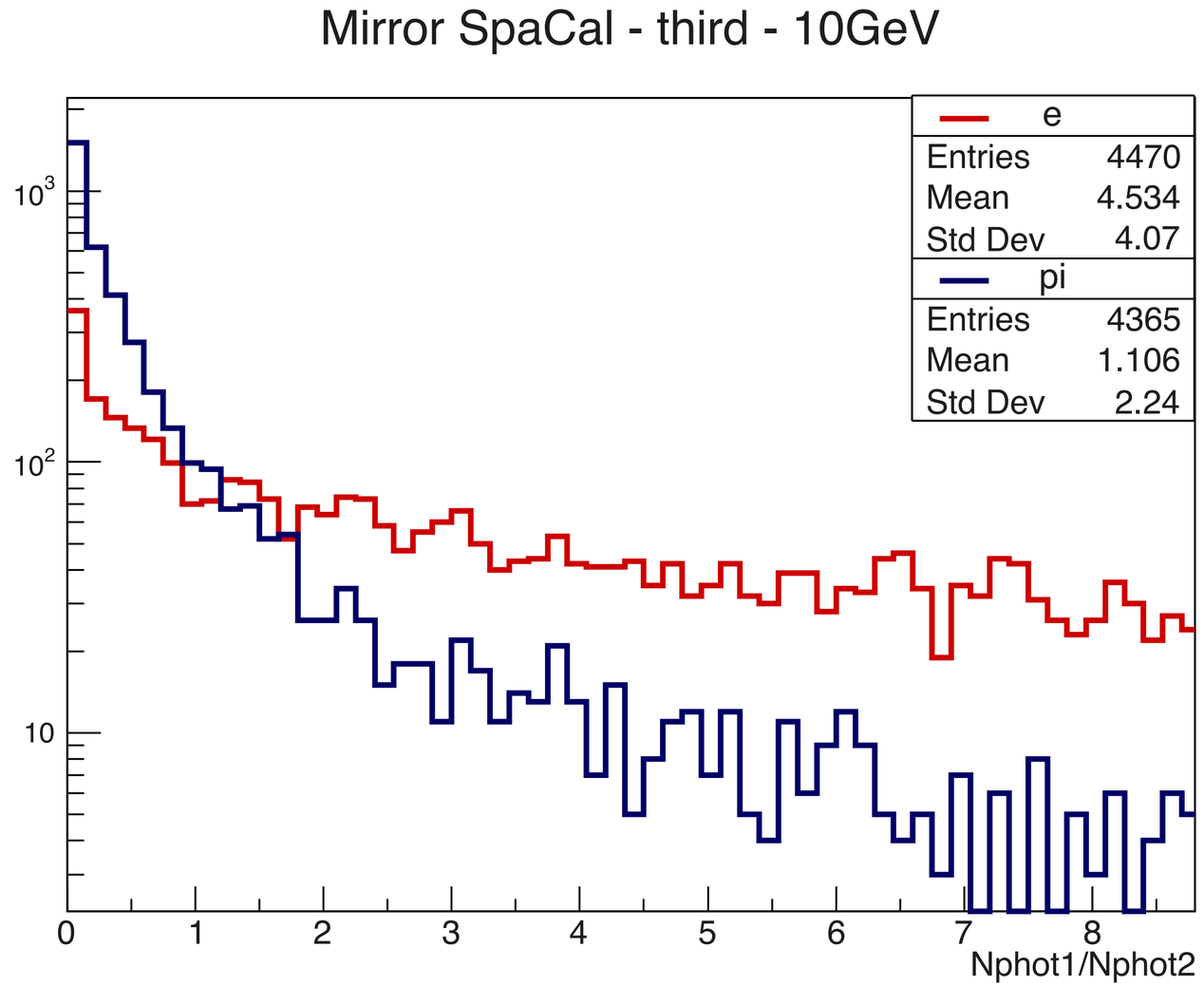
Mirror SpaCal - middle - 10GeV



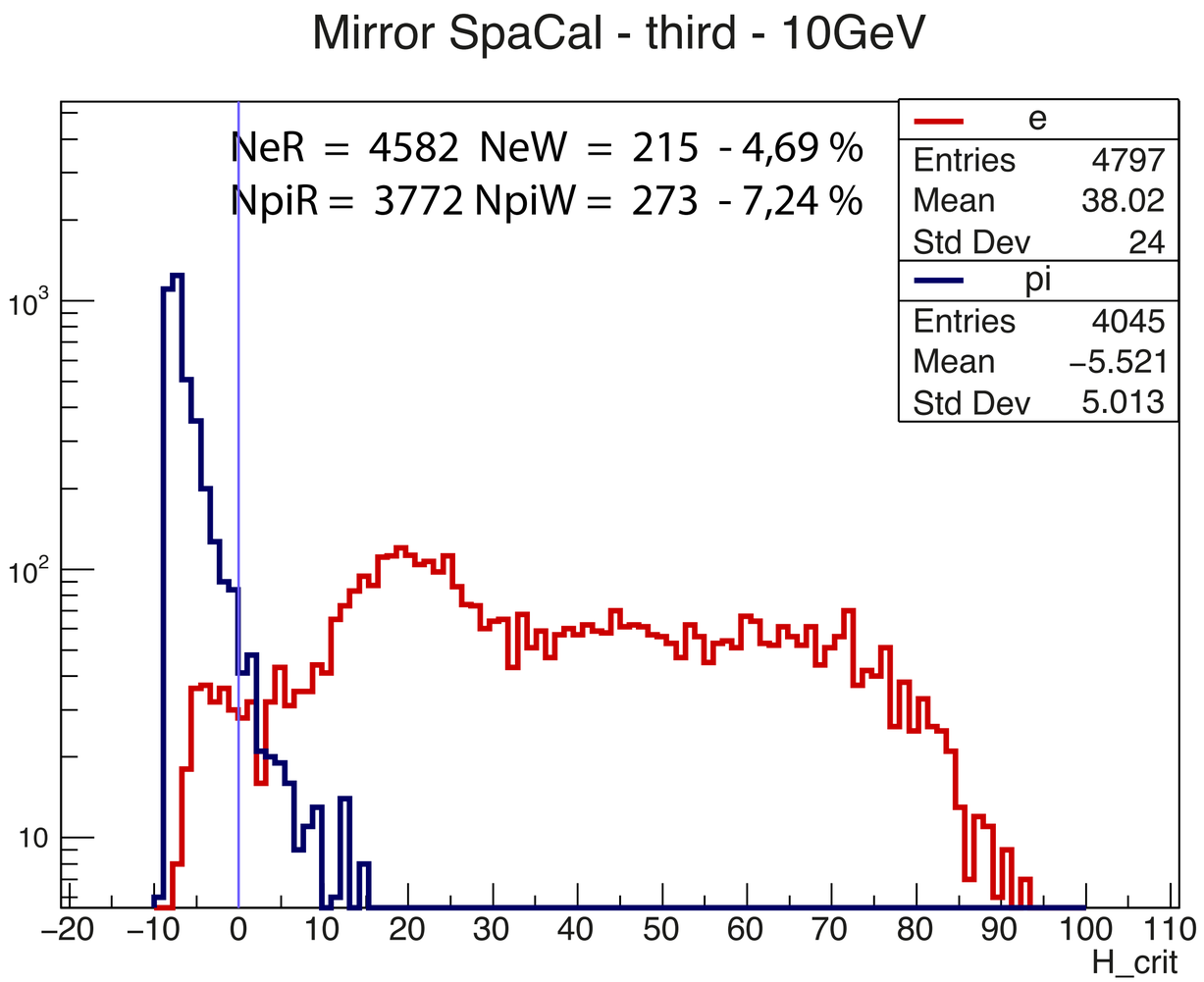


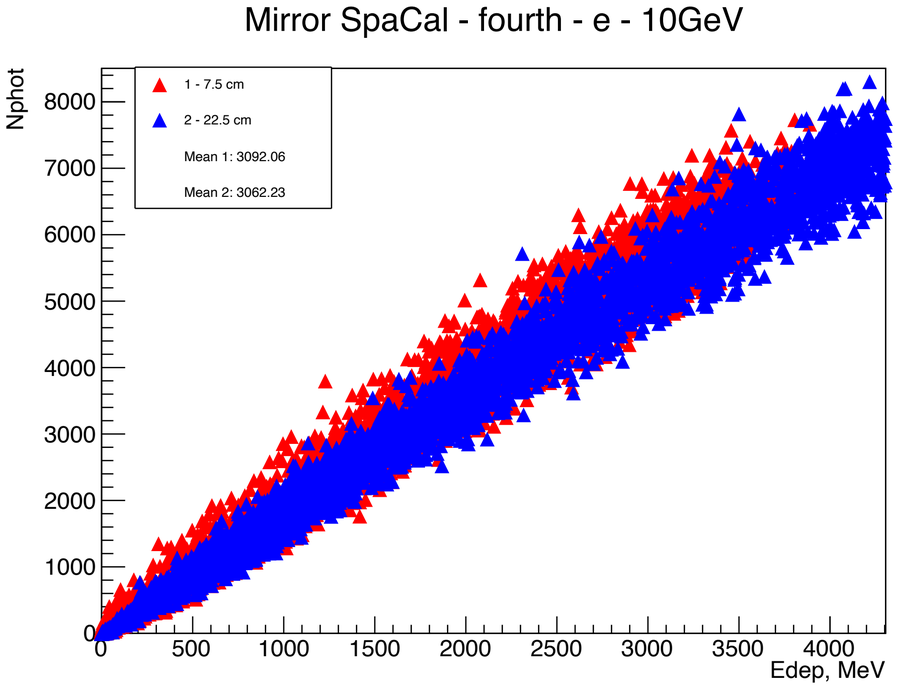


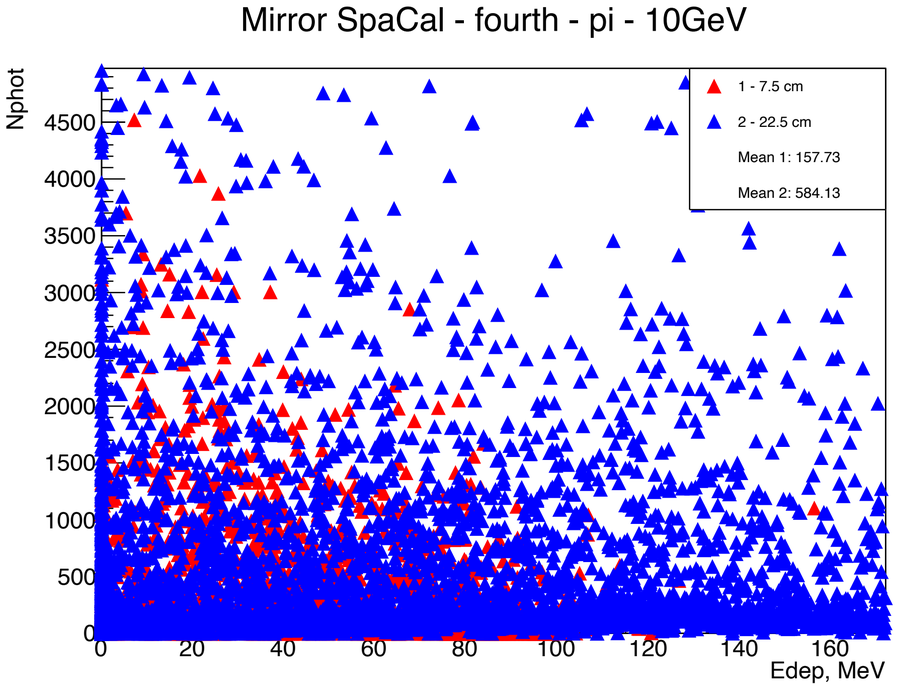
Расположение зеркала: 10см/20см. Было брошено 5000 первичных электронов и пионов с энергией 10 ГэВ. Точка входа частицы разыграна равномерно от -1,5 см до 1,5 см в плоскости xy.
Красные точки: энерговыделение и оптические фотоны до зеркала;
Синие точки: энерговыделение и оптические фотоны после зеркала.



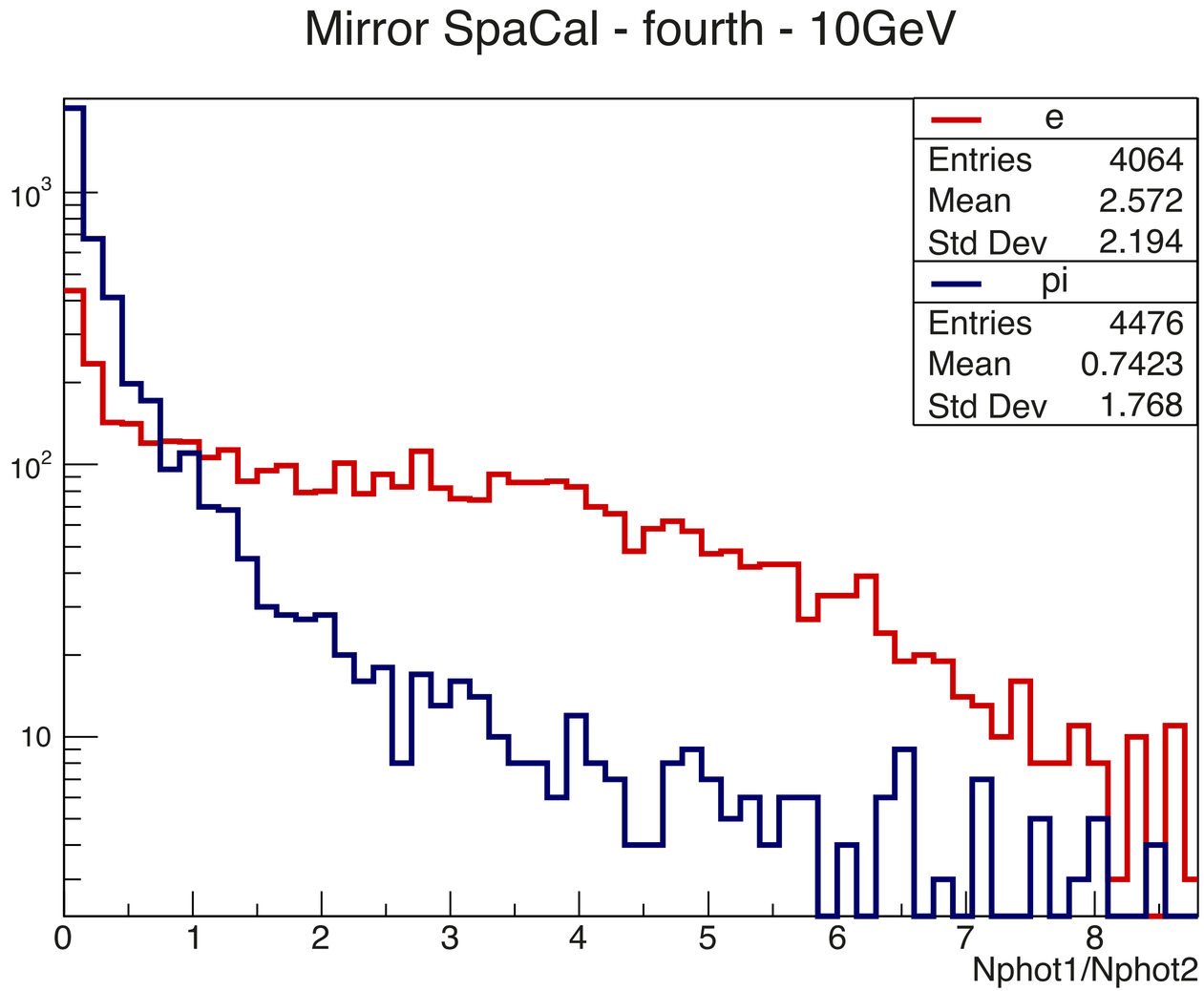
occupancy
энергии

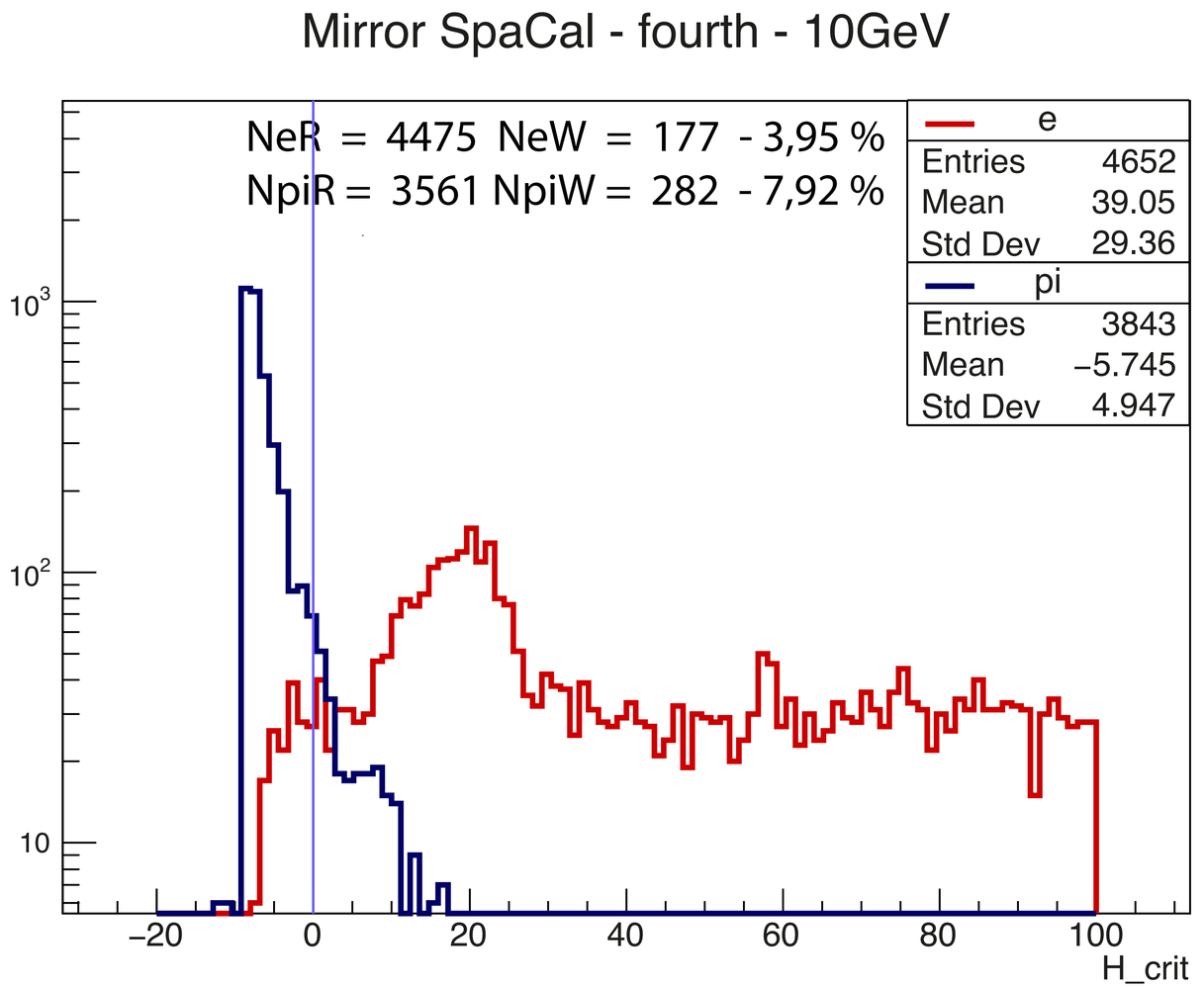






Расположение зеркала: 7,5см/22,5см. Было брошено 5000 первичных электронов и пионов с энергией 10 ГэВ. Точка входа частицы разыграна равномерно от -1,5 см до 1,5 см в плоскости xy.
Красные точки: энерговыделение и оптические фотоны до зеркала;
Синие точки: энерговыделение и оптические фотоны после зеркала.




Mirror SpaCal - fourth - 10GeV
NeR = 4475 NeW = 177 - 3,95 %
NpiR = 3561 NpiW = 282 - 7,92 %
e
Entries 4652
Mean 39.05
Std Dev 29.36
pi
Entries 3843
Mean −5.745
Std Dev 4.947
10^3
10^2
10
−20
0
20
40
60
80
100
H_crit